Who Takes the Best Moon Photos?

ASTRONOMY®

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Astronomy's Future: Dusk or Dawn?

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- **How to Sketch Starlight**

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10" LX200
8" LX200

Supplied complete per catalog specifications**:

8" LX200 Schmidt-Cassegrain	**$2495.**
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- For dealer or catalog information see the **Meade Starfinder Reflecting Telescope** ad in this issue.

Now with *one arc-minute* pointing accuracy and 64,350-object onboard database as *standard-equipment!*

Meade 8", 10", and 12" LX200 models with standard-equipment High-Precision Pointing™ software now automatically GO TO any input RA and Dec, or to any object in the 64,350-object database, to a pointing precision within one arc-minute!

New Meade Version 3.30 software and high-resolution encoders, used in conjunction with the unique Meade SYNC command, now yield the most precise automatic slewing ever offered in a commercial telescope, an observatory-level of precision and *more than 5 times the precision obtainable with any competing computer-controlled telescope.* Data entry through the telescope's keypad hand controller may be made either from the onboard 64,350-object library database *(see description at right)* or by inputting the desired object's RA and Dec.

Such precise object-acquisition, selectable during either altazimuth or equatorial operation of the LX200, has numerous important implications for the serious observer:

HIGH PRECISION POINTING

LX200's with High-Precision Pointing have a logo-plate affixed to the telescope's drive base.

All Meade LX200 models now include a 64,350-object onboard database as standard equipment.

Imagine having 64,350 celestial objects at the tip of your finger: 64,350 objects that you can center in the telescopic field just by entering and pressing GO TO on the hand controller. **More than 6 times the size of object libraries included with competing telescopes,** the Meade 64,350-object library includes an incredible array of phenomena—virtually a lifetime of deep-space study, even for the advanced observer:

12,921	galaxies from the Uppsala General Catalog; the complete UGC catalog.
7,840	objects from the New General Catalog; the complete NGC catalog.
5,386	objects from the Index Catalog; the complete IC catalog.
21,815	variable stars; the complete listing from the General Catalog of Variable Stars.
15,928	stars from the Smithsonian Astrophysical Observatory (SAO) catalog of stars brighter than 7th magnitude.
351	alignment stars for the LX200 telescope.
110	Messier objects; the complete listing.
8	major planets from Mercury to Pluto.
64,359	objects, total

LX200

SCHMIDT-CASSEGRAINS

☐ Use the GO TO command to *find and center an object in the field of a 4mm eyepiece.*

☐ With other telescopes, acquiring even bright objects on the chip of a CCD imager is generally a chore at best, searching and slewing by trial-and-error until at last the object is positioned on the chip. The LX200's High-Precision Pointing places *every* object on *every* CCD chip *every* time.

☐ Suppose you wish to CCD-image a supernova in an 18th magnitude galaxy—a galaxy invisible *except* through the process of CCD imaging. With Meade High-Precision Pointing, the galaxy can be placed on the chip of every commercially-available CCD unit.

☐ Photographing or imaging faint objects such as the planet Pluto, or comets and asteroids near the photographic limit of the telescope, and plotting the motion of these objects night-to-night, now becomes practical, since the photograph or image may be taken *without the observer ever having seen the object visually,* but knowing that the LX200 will place the object precisely in the telescopic field.

SPECIFICATIONS: 8", 10", and 12" LX200's—Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 Schmidt-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function control panel display on the drive base; manual and electric slow-motion controls on both axes; keypad handheld controller with digital readout display, permanently programmable Smart Drive™, 9-speed drive controls on both axes (7-speed on 12"), High-Precision Pointing, and GO TO controller; 64,350-object onboard celestial software library; 25 ft. power cord and adapter for telescope operation from 115v.AC (for field operation from any 12v. auto cigarette lighter plug, use the Meade #1812 Electronic DC Adapter, a 4-oz. unit available optionally); 8 x 50mm viewfinder with crosshairs; 1.25" diagonal prism (8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (8", 10") or giant field tripod (12"); foam-fitted carrying case; complete operating instructions.

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World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
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July 1995
Vol. 23, No. 7

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STUNNING REDS AND BRILLIANT WHITES are just two of the colors that make the cosmos so beautiful and colorful. Join noted astrophotographer David Malin on a tour of some of the most exquisite sights in the universe (page 30). Photo by David Malin © 1982 Royal Observatory, Edinburgh.

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BEHIND THE SCENES

Needed: More 5¢ Cigars

How do you know you're a backyard astronomer?

Well, the classic way to show you belong is to go out with a telescope and look at the universe. But that's not the only way.

Like any field, backyard astronomy has its little rituals of belonging. Observing is one of these, and so is buying a telescope. But if buying a scope is your main way to reaffirm a connection with astronomy, you aren't going to connect very often. A few fanatics accumulate telescopes like sports cards, but most of us buy only one or two in a lifetime.

Another way to connect with astronomy is to shop for accessories. Buying an eyepiece or a star atlas can provide a sense of involvement. If you've ever watched a crowd at a star party paw the swap-meet tables or pore over the latest goodies at a manufacturer's display — well, you've observed one of backyard astronomy's most cherished rituals of belonging. (Just stand back or you'll get trampled.)

But if this is the route to proclaim your membership, what do you find? Based on swap meets I've seen, you'll find dusty lenses and chipped mirror blanks, beat-up import eyepieces, and old computer hardware. Oh, yeah — and boxes of moldy books too. Not exactly stuff to stir the blood. It's true that if you shop the new equipment tables you'll find a whole lot more, yet here too the array seems remarkably thin. Sure, it's much more than it was a decade ago. (Thanks!) But it's still much less than it could be. There's just not a lot of stuff out there to feed that "desire to acquire" which seems part of any activity. If you doubt me, stroll into a hobby shop sometime or a camera store. Now those feed well-supplied activities, with many items in every price range.

A meager accessory market is a godsend only to the rank beginner feeling overwhelmed by the whole subject. If you're an initiate, though, it's pretty thin gruel. Ever notice how experienced amateurs wind up with dozens of eyepieces? Upgrading drives part of it, but I'll bet at least a few oculars get bought because they helped the buyer feel like an astronomer again.

A lot of hard thinking, many development dollars, and much effort go into today's accessories. But surely what's available isn't all there ever can be. Look at what pops up at star parties and amateur telescope meetings. Dobsonian scopes broke open the market for many beginners, and CCDs and computer control are the leading edge for today's techno-freak. What'll be the Next Big Thing in backyard astronomy?

So, manufacturers, you're facing a challenge. Let's see diversity and imagination — and a more varied accessory market. Have eyepiece designs truly reached an evolutionary end? Have aiming devices? Focusers? Drive controls? Mountings? And what about wholly new kinds of accessories, the ones we don't even have names for yet?

A broader market helps everyone — beginners and experts alike — to reconnect with the universe that enthralls us.

Sincerely,

Robert Burnham

Robert Burnham
Editor
rburnham@astronomy.com

LETTERS

Hello, Mir!

At a recent meeting of the Martz Astronomical Association a number of us were discussing the glory days of the space program and the impending budget cuts. We were reminded that one of the ways to show public support for NASA in the old days was for entire towns to turn on their lights as a Gemini capsule passed overhead.

Our club has proposed to NASA that astronomy clubs and groups across the country coordinate bursts of camera flashes as the Shuttle/Mir pair flies overhead this June.

Those interested in participating can contact me during the day at (716) 664-4506, during the evening at (716) 386-4566, or via e-mail at BEMUSABORD@aol.com. Get involved — support NASA and promote your club! — *Tom Bemus, public education director, The Martz Observatory, Jamestown, New York*

Dark Shadows Over the Land

"Totality, Cinema, and Crucifixion" by Joel K. Harris (November 1994) and the subsequent letter by Lucian J. Kemble (March 1995) both leave, well, a dark shadow on ASTRONOMY's basic astronomical knowledge. Perhaps Harris, Kemble, and your editors did not realize that for more than 1,000 years before Christ and 2,000 years afterward, the Jewish Passover meal occurs only on a night with a Full Moon.

But according to the Gospel's account, the Crucifixion occurred one day after the famous Last Supper, which means that it would take nothing short of a miracle to concoct a solar eclipse some 24 hours after that Full Moon. The problem, then, is not so much with the purported length of the darkness as it is with the Moon's being below the horizon during the Crucifixion. — *Yaron Sheffer, Astronomy Dept., University of Texas, Austin, Texas*

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Gary Kachar Graphic Designer

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Advertising Department (800) 558-1544

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The Audit Bureau

SALE!

Buy a Meade® 8" or 10" Schmidt-Cassegrain at a SPECIAL LOW PRICE *and* receive 2 eyepieces — a $75 value — FREE!

Through June 30, 1995, you can save on a Meade 8" or 10" Standard Series Schmidt-Cassegrain, and, in addition, receive two Meade Multi-Coated Eyepieces FREE!

SPECIAL PRICES**

8" Model 2080B, complete	**$1195**
10 Model 2120B, complete	**1495**

Packing & shipping: 8"—$75; 10"—$95.

***FREE Modified Achromatic Eyepieces:** With every 2080B or 2120B, Meade Instruments will include MA9mm and MA12mm eyepieces, (a $75.90 value) at no additional cost. *This free offer is valid between April 20 and June 30, 1995. Shown in photo:* MA9mm, MA12mm, and standard-equipment MA25mm eyepieces.

**Prices shown are suggested U.S. national mail-order retail prices, not including any applicable sales taxes or credit card charges.

8" Model 2080B: $1195, *including* equatorial wedge and field tripod.

10" Model 2120B: $1495, *including* equatorial wedge and field tripod.

Meade Standard Series Models 2080B and 2120B include a wide range of features not available on any other Schmidt-Cassegrains in their price range:

Multi-Coated Optics: Meade EMC Multi-Coatings *increase correcting plate light transmission to 99%+.* Competing Schmidt-Cassegrains include only a single layer coating on the corrector.

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TO ORDER: Call or visit your Meade Advanced Products dealer. ***Prompt delivery on both models.***

Specifications: Models 2080B, 2120B—Includes 8" or 10" f/10 optical tube assembly with EMC multi-coatings; fork mount with setting circles, manual slow-motion controls, and locks on both axes; 5.75" worm gear motor drive system (115v.AC/60Hz); eyepiece-holder (1.25"); diagonal prism; multi-coated MA9mm*, MA12mm*, and MA25mm eyepieces; 6 x 30mm viewfinder (8 x 50mm on 10"); standard equatorial wedge; variable-height field tripod; 6 ft. power cord; operating instructions.

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Shown with optional #637 6 x 30mm or #545 8 x 50mm Viewfinders

6" f/8
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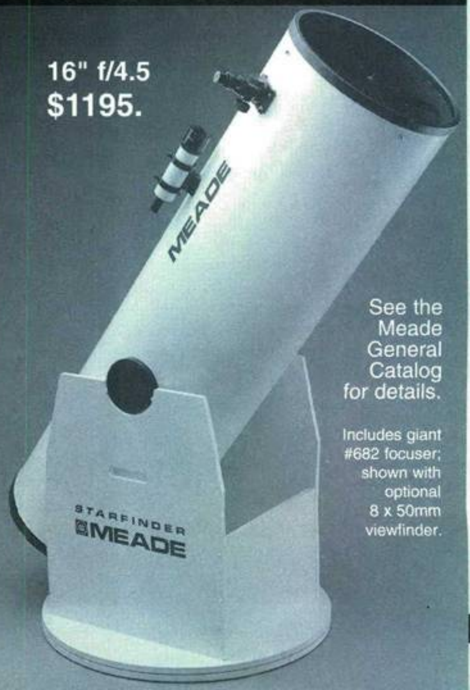
SPECIAL ACCESSORY OFFER!

At the time you order any Starfinder 6", 8", 10", 12.5", or 16" Dobsonian Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces *and* the Meade #637 6 x 30mm coated achromatic viewfinder with metal bracket for a *total* of only $49.95! Purchased separately, the 2 additional eyepieces and viewfinder sell for $125.85!** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA25mm eyepieces, with #637 6 x 30mm viewfinder.)* Offer valid until further notice.

Starfinder Dobsonian 16



16" f/4.5
$1195.

See the Meade General Catalog for details.

Includes giant #682 focuser; shown with optional 8 x 50mm viewfinder.

Compare Meade Starfinders *feature-for-feature* with other similarly priced Dobsonians!

- **Primary and Secondary Mirrors of Low-Expansion Pyrex® glass!** Unlike the plate-glass optics of other Dobsonians that can become thermally unstable (especially in larger apertures), Meade Dobsonians include the *exact same* professional-quality Grade-A, fine-annealed Pyrex® optical systems used on Meade Starfinder Equatorial Reflectors. Optics that meet the theoretical limits of resolution for their apertures.
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- **Optical Tubes:** Starfinder Dobsonians include the same strong, spiral-wound optical tubes used on Starfinder Equatorials *(facing page)*. All telescopes include a multi-coated MA25mm eyepiece as standard equipment. Each tube is factory pre-drilled for the optional 6 x 30mm or 8 x 50mm viewfinder.
- **Performance!** A Meade Starfinder Dobsonian or Equatorial Telescope opens up the skies to an extremely wide range of serious visual observing: all 110 Messier objects, thousands of NGC objects–nebulae, galaxies, star clusters, in all their variations of form, color, and extent, as well as the Moon and planets in stunning, high-resolution detail. Starfinder Dobsonians are telescopes for visual observing; motor-driven Starfinder Equatorials may be used, in addition, for lunar and planetary photography and even for limited deep-space astrophotography.
- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$39; 8"–$49; 10"–$69; 12.5"–$79. 16"–$45 packing, shipped *truck freight collect.*
- **To Order:** Contact one of the authorized mail-order dealers on the facing page.

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***Complete* 6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization... from $599.95!**

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$599.95

8" f/6
$699.95

10" f/4.5
$799.95

- **Electric Motor Drive** (115v/60Hz) with 6 ft power cord: permits **fully automatic** tracking of celestial objects; plugs into any standard outlet.
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- **Optional Accessories:** See the Meade accessories ad in this issue. Additional systems, including #55 Manual Declination Control, #43 Drive Corrector, and #47M Dual-Axis Drive Corrector, are described in the Meade General Catalog.

SPECIAL ACCESSORY OFFER! At the time you order any Starfinder 6", 8", 10", or 16" Equatorial Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces for a *total* of $29.95! Purchased separately, the two additional eyepieces sell for $75.90**. *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA25mm eyepieces.)* Offer valid until further notice.

- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$65; 8"–$75; 10"–$90. 16"–$55 packing, shipped truck freight collect.
- All prices shown are suggested USA mail-order retail prices, not including any applicable sales taxes.
- **Meade 1995 General Catalog** — $3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.
- For further information call Meade Instruments at 714-756-2291 or contact one of these authorized mail-order dealers:

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

CITY CAMERA, Dearborn, MI.
Orders: 800-359-5085; Info.: 313-846-3922.

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Orders: 800-621-2248; Illinois & Info.: 312-332-2000.

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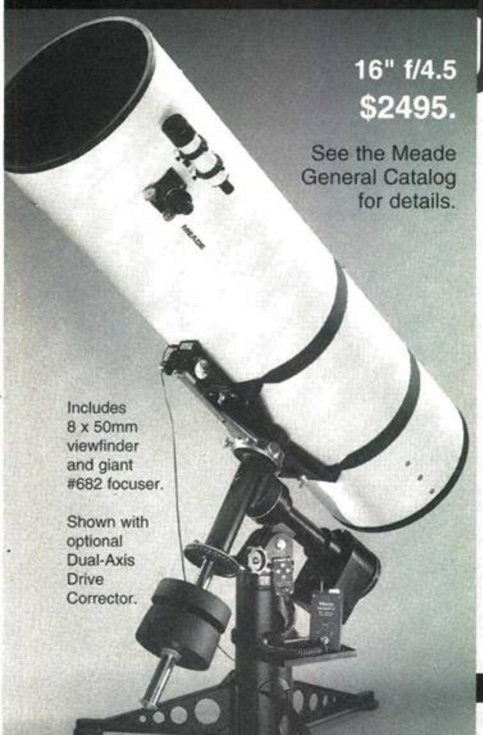
Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

Starfinder Equatorial 16



16" f/4.5
$2495.

See the Meade General Catalog for details.

Includes 8 x 50mm viewfinder and giant #682 focuser.

Shown with optional Dual-Axis Drive Corrector.

Standard equipment on 6", 8", and 10" models includes:

- **Superb Optical System:** Includes hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of low-expansion, Grade A, fine-annealed Pyrex® glass.
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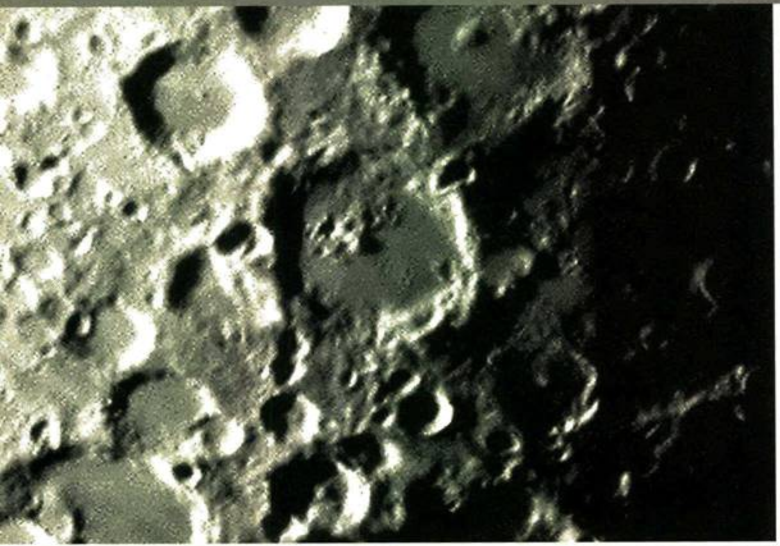

If you're ready to join the CCD revolution, send for a copy of the 76-page *Meade® 1995 General Catalog* ($3.00), which includes a substantive introduction to CCD astronomy, or contact your authorized Meade Advanced Products dealer. *Meade Pictor CCD imagers are available from $795.*

Upper left: **Meade Pictor 416 image by Steven Williams**—south polar region of the Moon. *Clockwise from upper right:* **Meade Pictor 1616 images by Jack Newton**—M101; NGC4565; M51.

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Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm each:	**$87.95**	(3.45)
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$79.95 (3.29)

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The very latest in eyepieces from Meade optical designers, new Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Available in a wide range of focal lengths from 5mm through 25mm. All five eyepieces are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. Manufactured exclusively for Meade Instruments by one of Japan's leading lensmakers, Series 3000 Plössls produce excellent results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$57.95** (3.45) **Any 2: $52.95** each; **Any 3: $48.95** each; **Any 4 or 5: $46.95** each.

Series 3000™ Plössl 40mm

A perfect complement to the Series 3000 Plössls at left, this all-new Plössl 40mm produces spectacular low-power, wide-field results with any telescope. Includes classical 4-element Plössl optics, multi-coated. Barrel dia. 1.25"; threaded for filters. Apparent field: 44°.

$79.95 (3.79)

Series 4000 Photo-Visual Color Filters (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue

each	**$14.95**	(2.29)
Moon Filter #ND96–Reduces brightness by 87%.	**16.95**	(2.29)
Set #1–4 filters: #12, #23A, #58, #80A	**54.95**	(2.98)
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Set #3–4 filters: #8, #21, #38A, #56	**54.95**	(2.98)
Sets #1 & #2–8 filters	**99.95**	(3.45)
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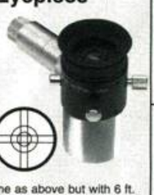
World's Most Advanced Illuminated Reticle Eyepiece



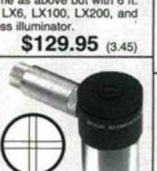
Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. **Internal batteries included.** Multi-coated optics. Bullseye reticle. 1.25"

$149.95 (3.45)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

$129.95 (3.45)

MA 12mm Illuminated Reticle Eyepiece



Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Wireless red LED illuminator and variable brightness control. **Batteries included.**

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MA 12mm—Same as above but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator.

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2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter. **$99.95** (3.79)

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Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.

.965": $27.95 (2.98) **1.25": $29.95** (2.98)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-mount for your camera.

$39.95 (2.98)

Tele-Extenders

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For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to any eyepiece-holder. Use with T-mount for your camera.

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#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"

$47.95 (3.45)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25"

$59.95 (3.45)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated.

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An improvement on the traditional Kellner design, these 3-element Modified Achromatic eyepieces give sharp, faithful, well-corrected images of the moon, planets, and deep-space at an economical price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. **MA 9, 12, 25, 40mm.**

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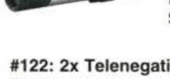

#140: Series 4000 2x Apochromatic Barlow Lens
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#122: 2x Telenegative Barlow Lens
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Regular: $59.95
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#126: 2x Short-Focus Barlow Lens
Regular: $47.95
Sale Price: $42.95

This special offer is valid between May 20, 1995, and August 31, 1995, at participating Meade dealers in the U.S.A. and is subject to product availability. Suggested shipping/handling charges shown under detailed product listings in this ad.

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#908N–Threads into 1.25" eyepieces, 26mm dia.	**89.95**	(2.98)
#910N–Threads into 2" eyepieces, 44mm dia.	**129.95**	(3.29)
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■ Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.

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LETTERS

— Nowhere does the article state that an eclipse took place at the time of the Crucifixion. Instead it describes how the moviemakers thought that a total eclipse would come close to mimicking the extraordinary circumstances of the day. As producer Dino De Laurentiis said, director Richard Fleischer and production designer Mario Chiari "conceived the idea that if they could film the crucifixion sequence against the eclipse they would be duplicating the lighting that must have happened on that fateful day nearly 2,000 years ago, 'when darkness fell upon the whole land.'"

Naval Observatory Telescope Available

PZT 7, a photographic zenith telescope located at the U.S. Naval Observatory in Washington, D.C., is available for use by amateur astronomers. The telescope is a 25-inch f/19 folded refractor designed for photographically recording the precise positions of stars as they pass overhead. Because astronomers at the Naval Observatory no longer need it, they are offering its use to parties proposing research or observational projects.

Naval Observatory astronomers are considering donating the instrument and its enclosure to interested parties, although they may also consider donating just the objective lens. Those who seek more information may contact the U.S. Naval Observatory, Code EO, 3450 Massachusetts Avenue N.W., Washington, DC 20392. — *Brent Archinal, U.S. Naval Observatory, Washington*

Make a Sky Pointer

I've discovered a way to avoid the frustration of star parties where everyone is standing around and can't see what the astronomer is pointing at in the sky. I use a pointer that sends a bright beam of light skyward, illuminating dust particles and water vapor. A wooden "baton" pointer combined with a modern laser pointer becomes a simple tool costing less than $15.

The light source is a Radio Shack "enerlite" lantern #61-2525. It has a quartz/halogen lamp with a well-collimated reflector and gives a narrow shaft of light that everyone in a group outdoors can see. To reduce light leakage, I made a light shield from a Quaker Oatmeal box.

Use fresh alkaline batteries and you'll have an impressive sky pointer that will allow you to show people the most obscure constellations, asterisms, and faint stars with ease. — *Frank Horine, Albuquerque, New Mexico*

Goddard Remembered

ASTRONOMY readers might like to know that a commemorative stone monument in Auburn, Massachusetts, marks the position of Robert H. Goddard's launch of the first liquid-fuel rocket on March 16, 1926. The monument, a three-foot-high granite obelisk, stands on what is now the site of a golf course, a short distance from the ninth hole.

The *real* price of a hobby is what it costs to sustain operations.

Phil Elrod,
Suwanee, Georgia

The monument, apparently erected in 1960 by the American Rocket Society, has developed a severe crack down one side and with time will deteriorate further. Are readers interested in helping to restore this monument? — *John Lockwood, 3040 Idaho Avenue NW, Apt. 119, Washington, DC 20016*

A Twenty-Ring Circus

There appears to be disagreement over the number of Uranian rings. The news story "Hubble Observes Uranus" (March 1995) states "a total of eleven concentric rings . . . circle the planet." In the middle of Carl Sagan's story "The First New Planet," he remarks "This . . . has led to the discovery of nine thin, dark rings surrounding the planet."

The difference isn't Earth-shattering, but which is correct? — *Webb Masten, Shelby, North Carolina*

— Astronomers observing an occultation of Uranus in 1977 discovered nine thin rings circling the planet. Subsequent observations by the Voyager 2 spacecraft revealed at least two more ringlets or clumps of material. The rings probably consist of many thin bands, but at least nine major rings and two ringlets exist.

Phobos Quibbles

I just saw my Phobos mosaic in AstroNews (April 1995). It's great to have it see the light of day! Thank you for not colorizing it. I can't resist relating a couple of quibbles: The image was printed backwards, and you misspelled Joe Veverka's name in the photo credit. — *Damon Simonelli, Cornell University, Ithaca, New York*

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David McGough, Millington, N.J.

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Tom Johnston, Boulder, Colo.

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Lee Johnson, Coquitlam, B.C. Canada

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David Broad, Santa Barbara, Ca.

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Costs of Backyard Astronomy

Recently several letter-writers complained of the cost of amateur astronomy. Over the years I've noticed that there is a dollar "constant" associated with just about any hobby. Today it lies in the range of $600 to $1,500.

This figure is pretty widespread: It applies not just to astronomy but to ham radio, scuba diving, fishing, tropical fish, bicycling, photography, audio — you name it. You can do it cheaper or you can spend a lot more. But this price will put you in there with some serious equipment. Actually, the *real* price of a hobby is what it costs to sustain operations. Photography can put you in the poor house, but astronomy or ham radio has just the initial cost of the equipment.

A loan or a credit card charge is reasonable for most employed people and minors can bank their paychecks until they've amassed enough. The real question here isn't "Are telescopes too pricy?" but "Are you serious about astronomy or just curious?" *Phil Elrod, Suwanee, Georgia, pelrod1018@aol.com*

Shower Makes a Good Show

The Aries-Triangulum meteor shower seems to be the most active annual shower for the month of September, according to the 1994 *ALPO Annual Review*. This report represents meteor observations made by the members of the ALPO Meteors Section last year.

Though the *ALPO Annual Review* lists the Aries-Triangulum as two showers, I think that it is actually different branches of the same one. Taking this into account, the sum of the meteors seen from both branches (92 meteors) represents the most active meteor stream seen this past September by the ALPO meteor observers. The second most active shower was the Alpha Aurigids; observers counted 78 meteors.

Unfortunately, the Moon will be Full this year three nights before the maximum of the Aries-Triangulum shower. Observe anyway, as the brighter meteors will still be visible despite the waning gibbous Moon. — *George W. Gliba, Greenbelt, Maryland* ☐

Astronomy welcomes feedback. Send your letters to Astronomy Letters, P.O. Box 1612, Waukesha, WI 53187, or on the Internet, use letters@astronomy.com. Letters may be edited for length and clarity.

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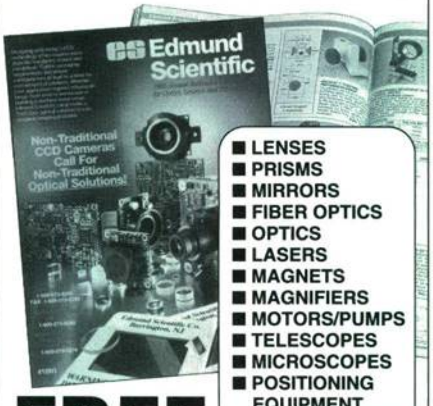
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The Saga of Mt. Graham

by Roger Angel, Peter Strittmatter, Bruce Walsh, and Nick Woolf

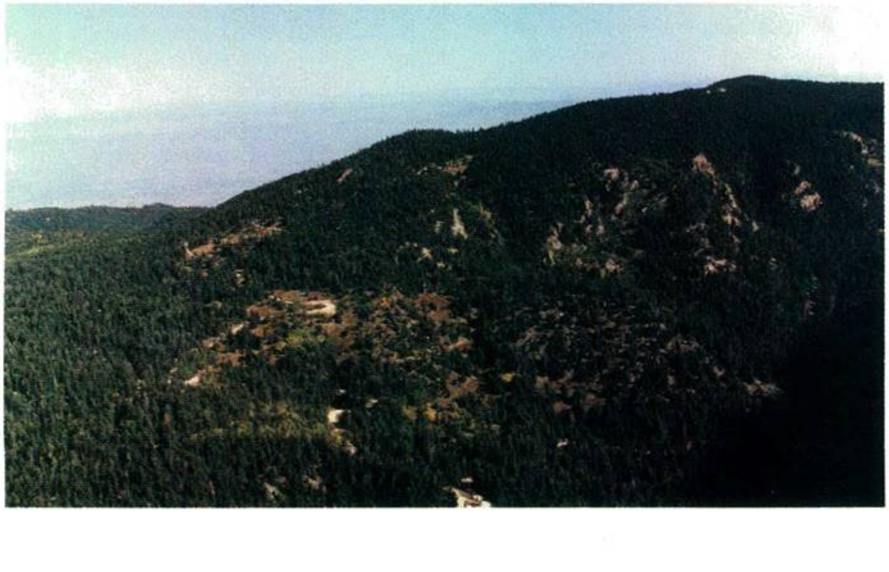
It is hard to imagine anything more environmentally benign than an astronomical observatory. Yet in the case of the Mt. Graham Observatory in southeastern Arizona, a small band of environmental activists seeks to derail telescope construction at one of the prime observing sites in the continental United States. At least one such new site is urgently needed because of the growing light pollution and inadequate altitude of most existing southwestern observatories. Beyond the present Mt. Graham controversy is the question of the future of ground-based observational astronomy in the United States.

At 10,700 feet, Mt. Graham is the most southerly mountain higher than 10,000 feet in the continental United States. More than a decade ago, after looking at several potential sites, astronomers selected Mt. Graham for the next generation of optical and infrared telescopes because of its clear skies, exceptional seeing, low water vapor, and minimal light pollution. The site also has easy access to elevations above 9,000 feet provided by a pre-existing paved highway.

Unfortunately, at the time this issue went to press, litigation by environmental activists had halted construction work on the mountain for the fourth time. A small but determined group, working through the Maricopa Audubon Society, claims that this sky island is an untouched wilderness ecosystem — a "veritable Galápagos of the desert." These opponents express particular concern for the endangered Mt. Graham red squirrel. Does the environmental situation justify this continued opposition?

No distinct species have been identified on the mountain, which closely resembles several other peaks in the region. The Mt. Graham red squirrel is a sub-population of one of the most abundant mammals in North America and was hunted on Mt. Graham until 1986. The highway, transmitter towers, 93 summer homes, and 250,000 recreational visitors per year have already strongly impacted the area. The mountain has also suffered over 5,000 acres of logging (see photo page 18) as well as the introduction of several alien animal and fish species. Mt. Graham is thus far from pristine, a fact that figured strongly in its selection.

Biologists, astronomers, and government officials have, in fact, paid enormous attention to minimizing the observatory's environmental impact. The 8.6-acre site represents one of the most effective uses of land for astronomical purposes anywhere in the world. Most observatory visitors comment on how little impact it has on the forest, and the observatory staff is proud of this. Perhaps this is why public opinion polls show



Steward Observatory

CAN YOU SPOT THE OBSERVATORY? The Mt. Graham Observatory is in the upper right corner. The entire facility covers a mere 8.6 acres of land.

that Arizonans support the project by a margin of more than 3-to-1.

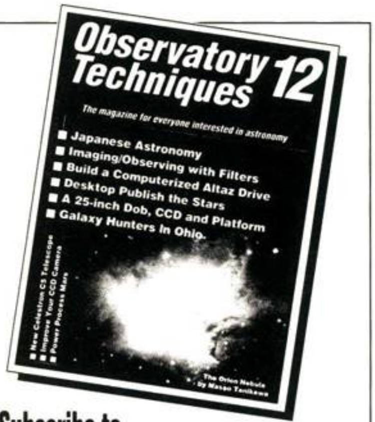
It was the observatory proposal and its associated public review process that focused some needed attention on the mountain ecosystem. Environmental studies revealed no major impact from the 8.6-acre observatory, but they did identify a number of other problems that have since been rectified. For example, logging has been halted and the squirrel protected. The University of Arizona is funding continued biological studies and has undertaken extensive reforestation on more than 60 acres of previously cleared woodland.

In 1984, after initial site testing, the University of Arizona submitted a formal proposal to the U.S. Forest Service (the federal agency responsible for the mountain) for an observatory on Mt. Graham. At the same time, astronomers worked with the Sierra Club to include a 3,500-acre Astrophysical Study Area and a 62,000-acre Wilderness Study Area on Mt. Graham; both were incorporated in the Arizona Wilderness Act of 1984.

Then in 1986, the U.S. Fish and Wildlife Service listed the Mt. Graham red squirrel as endangered. But in 1988, after four years of intense environmental study, the Fish and Wildlife Service cleared the way for an observatory on either Mt. Graham's 10,700-foot High Peak or a nearby 10,400-foot ridge known as Emerald Peak. The university, which had requested use of both peaks (both had existing access roads and clearings), selected Emerald Peak because of its better seeing.

Opposition to the observatory, led by the previously supportive Sierra Club, began to grow — even though two independent environmental impact studies (by the University of Arizona and the Fish and Wildlife Service) and two biological assessments (both by the Forest Service) identified no significant negative impact on the red squirrel population or the environment. Because opponents threatened further litigation and delay, which would have killed the project, the university sought congressional support for the recommendations made by the Forest Service and the Fish and Wildlife Service. This was granted in a 1988 federal law that authorized the immediate construction of three telescopes and necessary support facilities.

Observatory construction has proceeded ever since, albeit with interruptions. Preliminary observing has begun on two newly commissioned telescopes: the Vatican Observatory/



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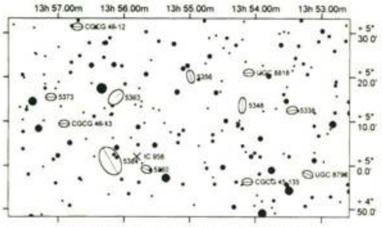

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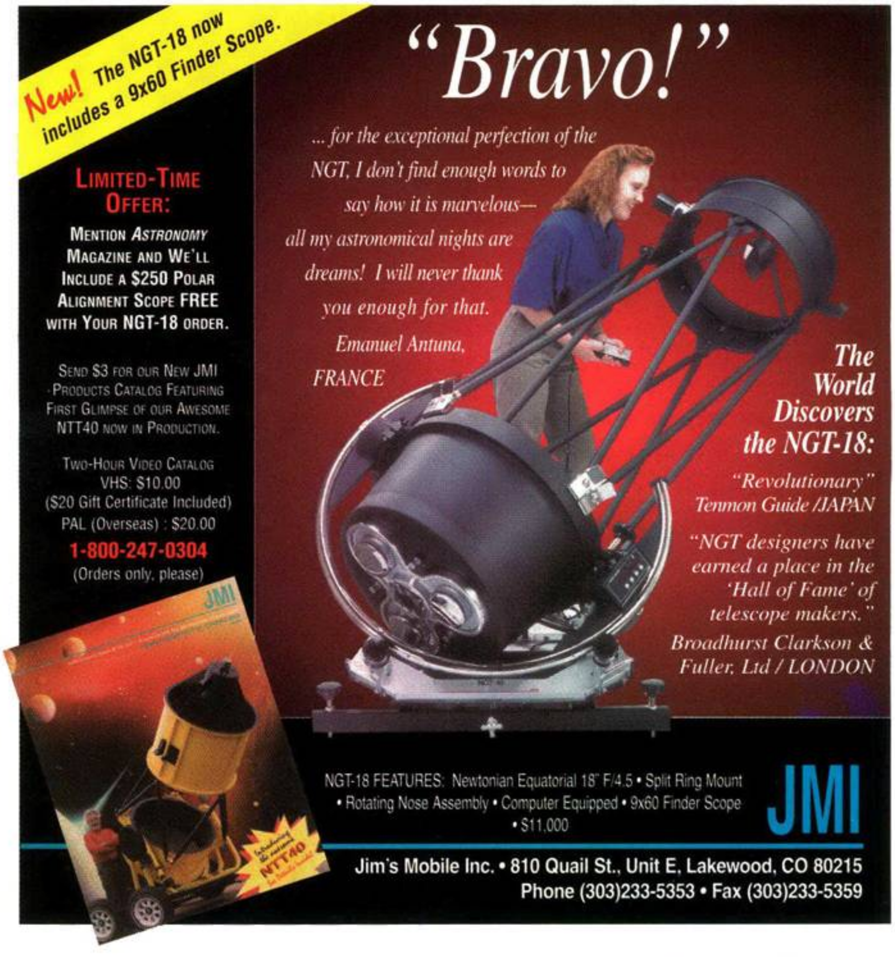

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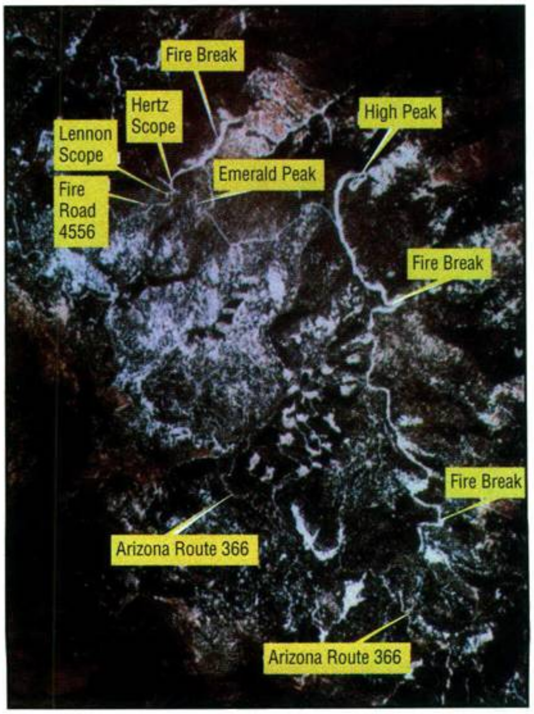
Arizona 1.8-meter Lennon Telescope and the 10-meter Heinrich Hertz Submillimeter Telescope, a joint project of the University of Arizona and the Max-Planck-Institut für Radioastronomie in Bonn, Germany. Routine astronomical use will begin on both later this year. The Lennon telescope, with its f/1 mirror made at the University of Arizona Mirror Lab, is already resolving details smaller than 1" in images 10' across.

The third and largest telescope planned for the mountaintop will be the dual 8.4-meter Large Binocular Telescope, a partnership between the University of Arizona, the Osservatorio Astrofisico Arcetri in Italy, and the Research Corporation in Tucson, Arizona. A site near the other telescopes was cleared in December 1993 with approval from the Forest Service and the Fish and Wildlife Service. The university's Mirror Lab is preparing to cast the first 8.4-meter mirror (the largest single-piece mirror in the world) in early 1996.

A HEAVILY IMPACTED MT. GRAHAM appears in this 1991 aerial photograph. Pre-existing roads and clear-cut areas have significantly disturbed the mountain. In contrast, the two completed telescopes have barely touched the peak.

Steward Observatory



But the anti-science opposition claims its campaign is a *jihad,* or holy war. In their crusade, they typically change tactics to keep court challenges alive. In a 1989 lawsuit against the Forest Service, opponents questioned the implementation of measures fo assist the endangered red squirrel. The litigation temporarily stalled work on the mountain. On each of nine counts the courts ultimately ruled in favor of the Forest Service but only after all parties had expended much time, effort, and money.

Apparently concluding that the red squirrel issue alone would not stop the observatory, opponents shifted their strategy in 1990. They began to claim that the 8.6-acre observatory represented "cultural genocide" for the San Carlos Apache tribe, whose reservation lies 40 miles to the north. They formed the "Apache Survival Coalition," which sued the Forest Service over alleged failure to carry out mandated cultural studies. The suit was dismissed in District Court. Furthermore, in 1993 the Apache tribal council took a neutral position on the observatory and the tribal chairman subsequently wrote to the Forest Service explicitly stating that the Apache Survival Coalition does *not* represent the tribe.

Most recently (April 1994), the same opponents (now called the Mt. Graham Coalition) filed suit against the Forest Service. The suit was based on the agency's decision to authorize a new Large Binocular Telescope site. This site was different from one that in 1988 satisfied the Endangered Species Act, according to the Fish and Wildlife Service. The planned move would take the site from 650 feet west of the Hertz Telescope to 650 feet east. This location would actually have less impact on the squirrel than the one chosen in 1988. It was unanamously approved by biologists from the Forest Service, the Fish and Wildlife Service, and the University of Arizona. Yet observatory foes contest it. They apparently care little about the squirrel.

Opponents won the first round in Federal District Court. They persuaded a judge (who had once before ruled against the project but was later overruled) that still more biological studies are necessary. The Department of Justice and the University of Arizona have appealed to the 9th Circuit Court in San Francisco and now await the Appellate Court's ruling.

Legal action is, however, only one weapon used against the observatory. A second is deliberate propagation of misinformation designed to make it difficult for others to participate in the project. The opponents claim that the observatory threatens the endangered red squirrel. Yet they know that estimates based on a worst case scenario suggest that the observatory might reduce the mountain's red squirrel carrying capacity by only about 0.8 squirrel when populations are high (around 500) and by proportionately less when they are low. Observatory construction has caused zero squirrel deaths in six years while mandated squirrel monitoring has caused three. In fact, the squirrel count has more than doubled (from around 150 to over 400) since construction began. But despite these facts, the opponents endlessly repeat their refrain that the squirrel is threatened.

Although the University of Arizona and its collaborators have borne the brunt of this anti-science campaign, the issue is nonetheless important to all astronomers. Sites both suitable and available for world-class telescopes are very rare. If activist campaigns can deny astronomers access to even 8.6 acres of Mt. Graham's already highly impacted 200,000 acres, then one wonders whether any site of comparable quality will ever be available to astronomy in the United States.

In the meantime, opponents continue to delay construction of the Large Binocular Telescope, even espousing positions detrimental to the squirrel, their original concern. This is bad for the squirrel, bad for science, and bad for the public, which, one way or another, is footing the bill. It is also bad for the Endangered Species Act, whose laudable purpose is being subverted to achieve land-use decisions promoted by a small minority of radical activists. Let's hope that the future will see a more rational approach to reaching such decisions and that astronomy will continue to flourish in the southwestern United States, as it has for the last century. ☐

Roger Angel, Peter Strittmatter, and Nick Woolf are astronomers at the Steward Observatory and Bruce Walsh is a population biologist in the Department of Ecology and Evolutionary Biology, all at the University of Arizona in Tucson.

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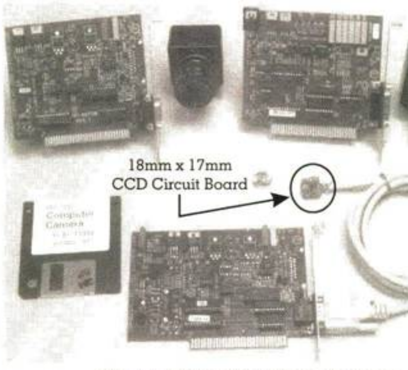

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ASTRO NEWS

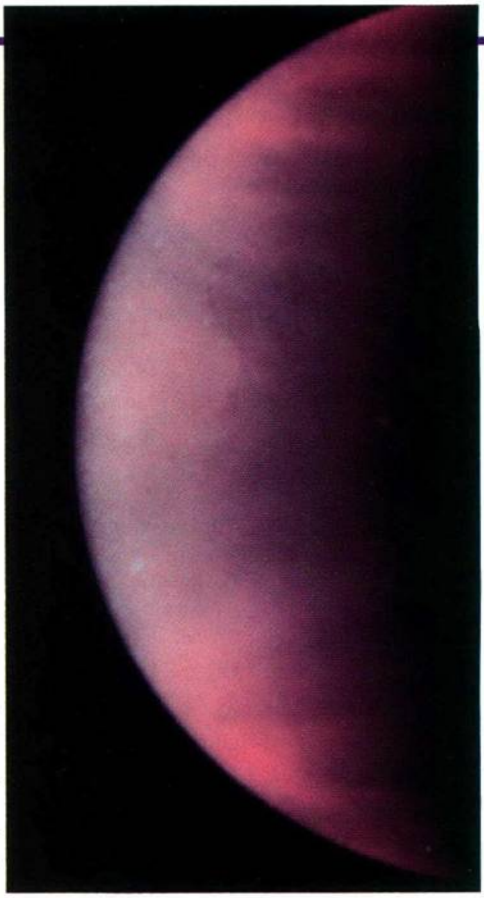
Jupiter's Moon Europa Has Oxygen Atmosphere

Europa, one of the four large Galilean moons of Jupiter, has a thin atmosphere of molecular oxygen, reports a team of scientists in the February 23, 1995 issue of *Nature*. The team made their discovery with the Hubble Space Telescope's Goddard High Resolution Spectrograph. The only moons previously known to possess an atmosphere were Io, Titan, and Triton.

The oxygen, says team member Doyle Hall of Johns Hopkins University, most likely comes from Europa's surface, which has a crust of water ice. Sunlight causes some of this water ice to vaporize into an atmosphere. More oxygen may be relased into the atmosphere when Europa's surface is bombarded by charged particles trapped in Jupiter's magnetic field. Solar ultraviolet radiation ultimately breaks the water apart into its constituent hydrogen and oxygen molecules. The lightweight hydrogen escapes into space, and the heavier oxygen stays behind.

People thinking there's life on Europa shouldn't get too excited, however. The temperature there is extremely cold by Earth standards — 128 kelvins (–230° F) — and the atmosphere exerts a surface pressure a mere 100 billionth that of Earth.

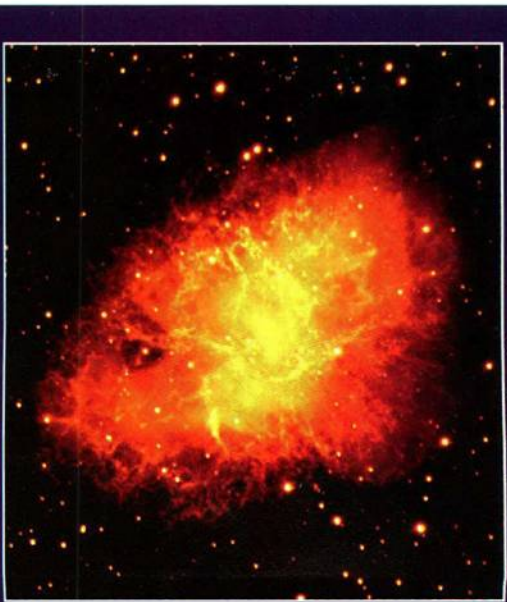
Scientists are now planning to make more detailed observations of Europa and its atmosphere after the Galileo spacecraft arrives at Jupiter on December 7 this year. At closest approach, Galileo will fly within 600 kilometers of Europa's icy surface.



Larry Esposito (University of Colorado) and NASA

TELLTALE SIGNS of a dynamic atmosphere show up in this ultraviolet image of Venus taken by the Hubble Space Telescope on January 24. Scientists used HST's Goddard High Resolution Spectrograph to determine that sulfur dioxide levels in the clouds continue to drop. Planetary scientists think large amounts of the compound were dumped into Venus's atmosphere by a massive volcanic eruption in the late 1970s.

THE CRAB NEBULA in Taurus was one of the first objects imaged by the new Vatican Advanced Technology Telescope on Mt. Graham in Arizona. The success of this 1.8-meter scope indicates that the Large Binocular Telescope (to be built on Mt. Graham) and the 6.5-meter Magellan Telescope (to be built in Chile) will work as planned: They use the same mirror and telescope designs. The sharp images also show that Mt. Graham is as superb an observing site as astronomers predicted, revealing details in astronomical objects only 0.6 arcsecond across.



Richard P. Boyle, S.J., Vatican Observatory

Io Erupts Anew

A major eruption shook Jupiter's volcanically active moon Io in early March, causing its infrared brightness to double. John Spencer of Lowell Observatory in Flagstaff, Arizona, and his colleagues detected the outburst on March 2 with the 3-meter infrared telescope at NASA's Infrared Telescope Facility on Mauna Kea, Hawaii.

At a wavelength of 4.8 micrometers, the volcanic hot spot appeared as bright as Io's entire sunlit hemisphere. By March 9 the hot spot's brightness had diminished greatly, though it could

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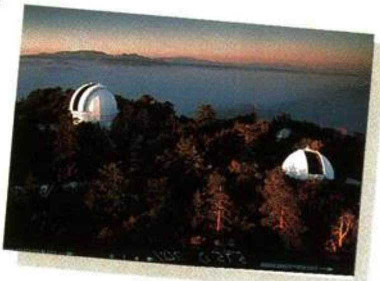

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still be seen. The region of the eruption, as well as the rest of Io's surface, will come under intense scrutiny beginning in December, when the Galileo spacecraft arrives at Jupiter.

Cirrus Clouds Brighten the Far UV

Astronomers have suspected that starlight scattering off dust grains in interstellar space accounts for most of the sky's diffuse brightness at far-ultraviolet wavelengths (between about 1300 and 1800 angstroms).

Now they have confirmed this relation by showing that individual dust clouds (galactic cirrus) observed in the visible and infrared also appear bright in the far UV.

Lauri Haikala and Kalevi Mattila of Helsinki University Observatory, Stuart Bowyer, Timothy Sasseen, and Michael Lampton of the University of California at Berkeley, and Jens Knude of Copenhagen University Observatory discovered and imaged the first cirrus cloud at far-UV wavelengths. They will report their findings in an upcoming issue of the *Astrophysical Journal.*

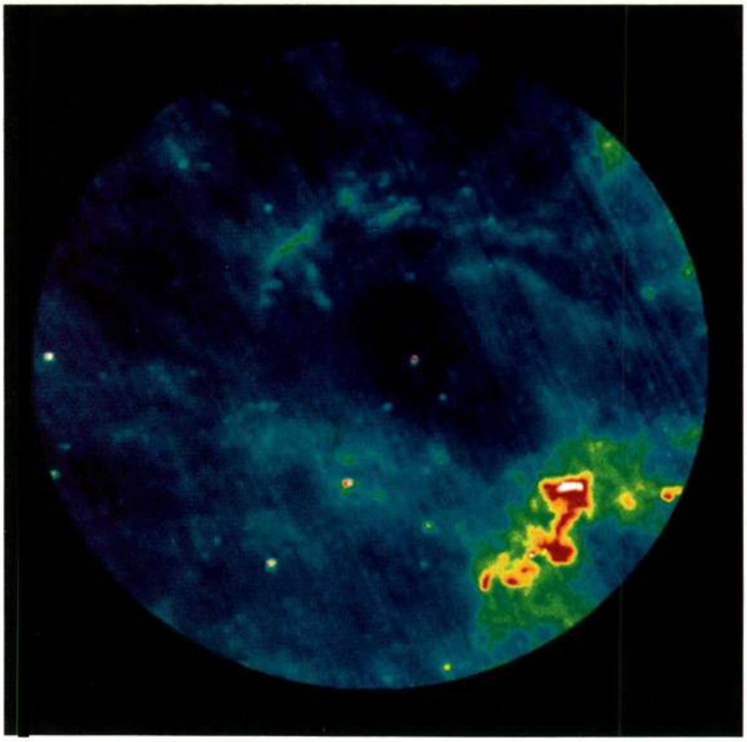
The team used the Far Ultraviolet Space Telescope, which flew on the ATLAS-1 space shuttle mission in March 1992, to examine the cirrus cloud in a region near the north galactic pole in Coma Berenices. They later compared their far-UV view with images from the Infrared Astronomical Satellite and optical telescopes. The three views matched very closely: The infrared view recorded the heat given off by the dust, the optical showed the dust-reddened light coming from beyond, and the far UV revealed the light from nearby hot stars scattering off the dust. The researchers conclude that dust in our own Galaxy must explain the majority of the background sky glow seen at far-UV wavelengths.

First Stellar Oscillations Seen

Astronomers from Aarhus University in Denmark and the European Southern Observatory found that the 3rd-magnitude star Eta Bootis oscillates with a period of about 20 minutes. This is the first observation of oscillations in a Sun-like star. The group is led by Hans Kjeldsen of Aarhus.

Eta Bootis is a G0-type subgiant that is about 10 percent more massive than the Sun and about twice as large. The 20-minute period confirms predictions that say massive stars the size of Eta should oscillate about four times slower than the Sun's 5-minute period. The star is a bright feature of the springtime sky and is visible to the naked eye.

The researchers used the 2.5-meter Nordic Optical Telescope on La Palma in the Canary Islands to measure Eta's temperature and detect periodic variations of about 0.005 kelvin, signaling that the star oscillates.



Lauri Haikala, Helsinki University Observatory

A CLOUD OF DUST glows brightly (lower right) near the north galactic pole in this image from the Far Ultraviolet Space Telescope. Deep blue indicates the darkest far-UV sky brightness and red and white the brightest. Comparing this image to optical and infrared images shows that dust accounts for most of the background glow at far-UV wavelengths.

University of Wisconsin

FAINT OUTER WISPS of slowly expanding gas give a new shape to the familiar Ring Nebula in Lyra. This image from the 3.5-meter WIYN Telescope on Kitt Peak, Arizona, shows the bright portion of the Ring with unprecedented sharpness.

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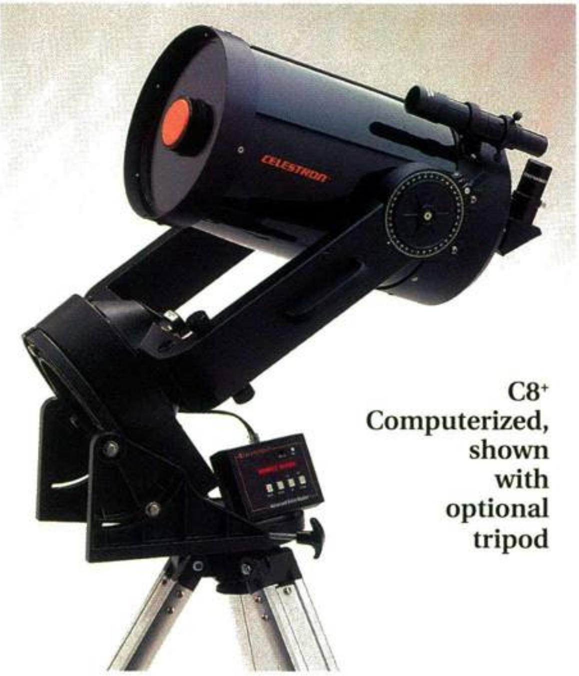

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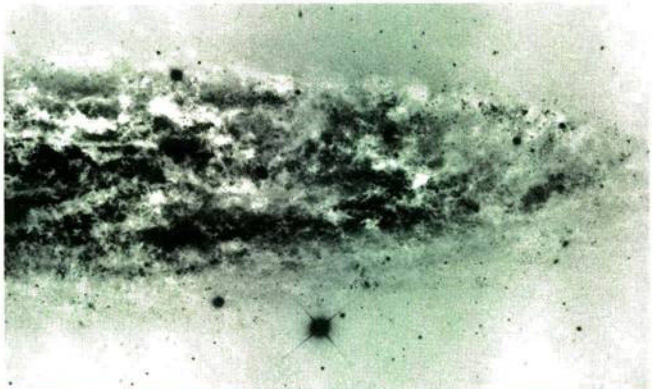
Do Cosmic Rays Spark High-Altitude Flashes?

The mysterious bursts of light that flash upward from the tops of particularly intense thunderstorms may result from a storm of electrons sparked by a single cosmic ray. Los Alamos National Laboratory scientists Yuri Taranenko and Bob Roussel-Dupré presented their theory at the December 1994 meeting of the American Geophysical Union in San Francisco.

The researchers suggest that the storm starts when a fast-moving cosmic ray smashes into an air molecule; this generates a single high-energy electron. The electric field that builds at the tops of lofty storm clouds then accelerates the electron upward, where it collides with other air molecules and frees additional electrons.

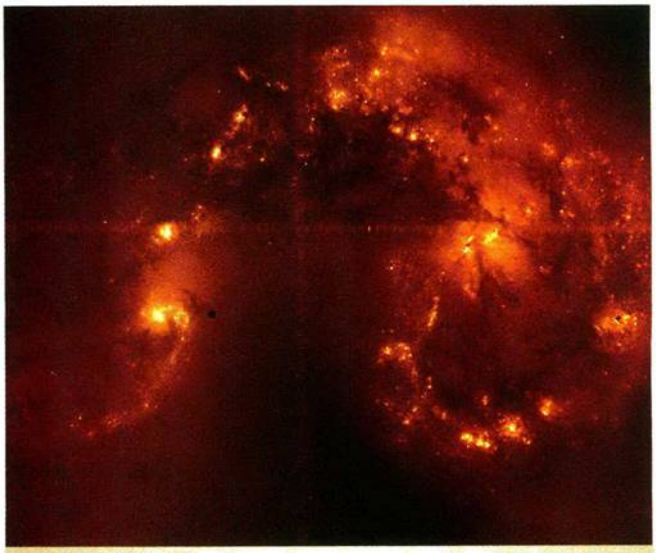
These electrons join the process, kicking free yet more electrons and quickly creating an upward-moving storm that can climb some 30 miles above the cloudtops and spread a dozen miles wide. The process unfolds in less than a thousandth of a second and leaves the upper atmosphere flashing brightly as the high-speed electrons excite air molecules.

Computer simulations show that this model produces the observed intensities and colors of the lightning as well as the height at which they occur. The fast-moving electrons can also generate gamma rays, and this could explain gamma-ray flashes seen in the upper atmosphere by the Compton Gamma Ray Observatory (see AstroNews, January 1995). However, researchers do not yet know whether the gamma-ray flashes are associated with the lightning flashes or even with thunderstorms.



Yoshiaki Sofue, University of Tokyo

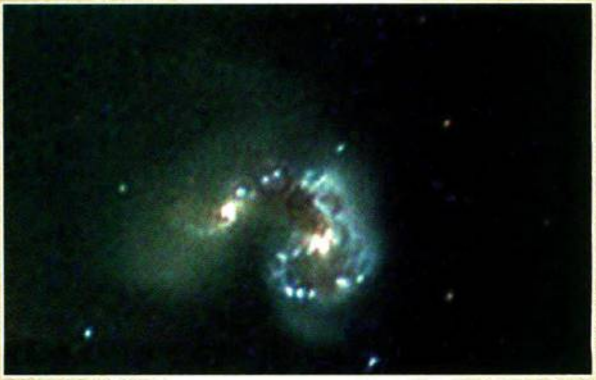
DARK LANES AND FILAMENTS OF DUST twist through the Sb-type galaxy NGC 253 in Sculptor. This new unsharp-masked image made with the 3.9-meter Anglo-Australian Telescope supports a "boiling disk" model of the galaxy. The model, proposed by a team led by Yoshiaki Sofue of the University of Tokyo, proposes that bursts of star formation, supernova explosions, and magnetic fluxes in the galaxy's disk have produced a variety of dusty features. The features include dust bubbles, arcs, streamers, loops, vertical filaments, and a superbubble near the galaxy's center sculpted by a supernova blast.



Bradley Whitmore, STScI, and François Schweizer, CIW/DTM

TWO COLLIDING GALAXIES (NGC 4038 and 4039) known as the Antennae are beginning to merge and, in the process, are forming new stars. The galaxies lie about 90 million light-years away in the constellation Corvus. The Hubble Space Telescope image above, taken with the Wide Field and Planetary Camera before the 1993 servicing mission, shows detail not seen by ground-based scopes (below).

Bradley Whitmore of the Space Telescope Science Institute in Baltimore and François Schweizer of the Carnegie Institution of Washington in Washington, D.C., found more than 700 blue, pointlike objects within the disks of the galaxies. They believe these may be young globular star clusters perhaps only 10 million years old. They also discovered that the clusters gather in groups of about a dozen around giant hydrogen gas clouds, the sites of their formation. Whitmore and Schweizer presented their results at the January meeting of the American Astronomical Society in Tucson, Arizona.



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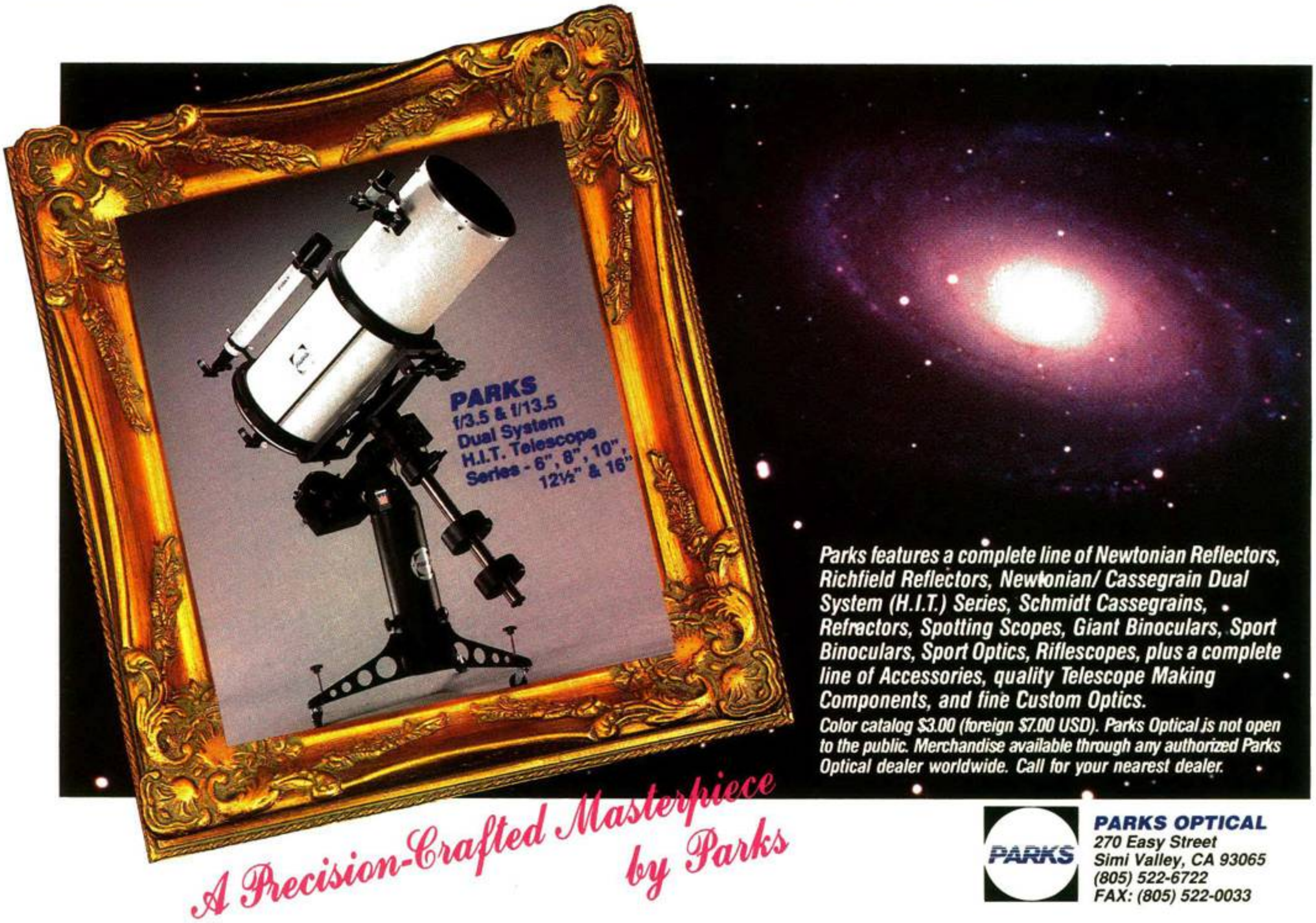
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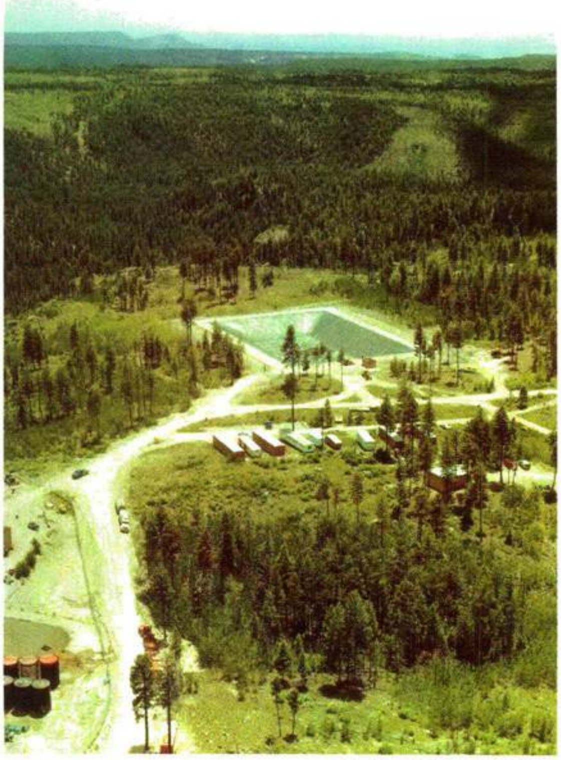
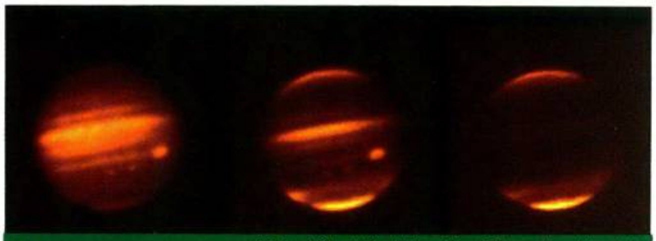


Los Alamos National Laboratory

Gamma-Ray Telescope Takes Shape

Within about two years, the large hole in the ground (above) will hold a sophisticated telescope for observing gamma rays from the cosmos. The observatory, named Milagro and located on Fenton Hill in northern New Mexico's Jemez Mountains, will consist of a 25-foot deep, 5-million-gallon artificial pond with a submerged array of 800 sensitive light detectors and another 200 detectors positioned around the pond. It is a collaboration among Los Alamos National Laboratory, the University of California's Irvine, Santa Cruz, and Riverside campuses, the University of Maryland, George Mason University in Fairfax, Virginia, and New York University.

When gamma rays strike air molecules, they produce showers of subatomic particles that head toward Earth's surface. The observatory will detect the light created when the particles hit the water. Astronomers plan to use Milagro to search for signs from the explosive death throes of evaporating black holes, to study the violent cores of active galaxies and quasars, and to provide new details of the powerful but enigmatic gamma-ray bursters.



Michael Skrutskie, University of Massachusetts, et al.

PLUMBING THE DEPTHS OF JUPITER reveals how debris from last July's comet crash still lingers high in the planet's atmosphere. From left to right, three near-infrared images taken at successively longer wavelengths (1.6, 2.1, and 2.2 micrometers) for the most part show successively higher levels of Jupiter's atmosphere. The debris band is most noticeable in the longest wavelength, betraying its 50- to 100-kilometer altitude above Jupiter's main cloud layer. Kester Allen (Amherst College), Michael Skrutskie, and David Morris (both of the University of Massachusetts) obtained these images on January 14 using the 2.4-meter Hiltner telescope on Kitt Peak in Arizona.

Chiron: Smaller But Brighter?

New measurements of 2060 Chiron, a large comet that orbits the Sun beyond Jupiter, show that its diameter is 170 kilometers, only about half that previously believed. Because Chiron's brightness is known and the comet is much smaller than previously thought, Chiron's assumed reflectivity should be increased to about 13 percent — high enough to suggest that its surface could be partly covered with ice.

After its discovery in 1977, astronomers thought Chiron was an asteroid. But when it developed a gaseous and dusty coma, planetary scientists reclassified it as a comet. (See AstroNews, March 1995.) Previous measurements indicated that Chiron was both large and dark: up to 300 km in diameter with a reflectivity of about 3 percent.

To check those results, planetary scientists Wilhelm Altenhoff and Peter Stumpff of Germany's Max-Planck Institut für Radioastronomie employed the 30-meter Institut de Radio Astronomie Millimétrique telescope in Granada, Spain, to redetermine Chiron's size. While their result disagrees with results from previous work, it's consistent with the latest infrared findings. Altenhoff and Stumpff suggest the possibility that cometary outbursts distorted the earlier size measurements. Their work appears in the January (I) 1995 *Astronomy and Astrophysics*.

In other news about Chiron, observations made from the Kuiper Airborne Observatory and the South African Astronomical Observatory during a March 9, 1994 occultation of the star Ch08 revealed at least two discrete jets of ice particles emanating from the worldlet's surface.

This finding indicates that Chiron's coma originates from a few regions — perhaps geyserlike vents similar to those found on Neptune's satellite Triton — rather than from uniformly vaporizing over its entire surface. The findings are discussed in the January 5, 1995 *Nature*.

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Scopes, Surf, and the Southern Cross

Gentle sea breezes, the rustle of palm trees, and a field full of scopes under the approving eye of Crux, the Southern Cross. That's what greeted the 600 people who gathered on West Summerland Key, Florida, for the 11th annual Winter Star Party. Miami's Southern Cross Astronomical Society sponsored the event from February 27 through March 4.

Amateur astronomers crammed every nook and cranny of a leased Girl Scout camp with scopes of various design and aperture. Sarasota, Florida amateur Tom Clark anchored the large scope category with his 36-inch Dobsonian. The behemoth, which he coined "Yard Scope" because of its 3-foot-wide mirror, gave stunning views of globular and open star clusters scattered along the winter Milky Way. Arranged nearby, in an area quaintly referred to as the "Valley of the Dobs," were dozens of other Dobsonians packing apertures greater than 13 inches.

ASTRONOMY: John Shibley

WINTER STAR PARTIERS gather under palm trees on the meeting's last day for the presentation of door prizes. Commercial vendors generously doled out everything from eyepieces to paintings of astronomical objects.

Perhaps the telescope with the most intriguing story was one that harkened to days gone by. As a teenager growing up in New York during the late 1950s, Richard DeLuca dreamed of owning a Unitron Model 601 4-inch f/15 refractor, complete with a teak wood carrying case, a 4x5 sheet film camera, and an all-brass, Swiss-made clock drive. "I saved and saved, but never managed to have enough to buy one," he recalls.

For almost forty years, the dream went unfulfilled until January, when he happened onto an estate sale. "There it was — a Model 601 in mint condition, hardly used," says DeLuca. He immediately snatched it up; it saw "first light" with Mars under the rock-steady south Florida skies.

DeLuca wasn't the only person watching Mars. Chicagoan Jim Carroll scrutinized the planet using magnifications close to 700 power. He and fellow observers routinely saw a tiny north polar cap and distinct dark markings through his 18-inch f/6 reflecting telescope. When not eyeing the Red Planet, Carroll spotted 18 stars in an area around the Orion Nebula's Trapezium star cluster. (Most northerners see six on a good night!)

Night owls had until noon to sleep, for that's when crowds greeted tables of vendors and the talks began. Deep-sky photographer Jack Newton and planet imager Don Parker shared their latest CCD images. *The CCD Camera Cookbook* author Richard Berry talked shop with dozens of people who built, or were planning to build, his CCD camera kit. And as a foil to all this techno-babble, North Carolina amateur Tom Lorenzin recited astronomy poetry to music — a real crowd pleaser.

Next year's Winter Star Party bliss runs from February 12 through 18. For registration information, write WSP '96, 5401 SW 110 Avenue, Miami, FL 33165 or phone (305) 595-8778.

Jay Gunter, Asteroid Popularizer

Jay U. Gunter, the man responsible for inspiring a generation of asteroid observers through his publication *Tonight's Asteroids*, died peacefully on November 14, 1994. He was 83.

After his retirement as a physician in 1976, Gunter started publishing *Tonight's Asteroids*, a free bimonthly newsletter with finder charts and news about visible asteroids. For 15 years, the publication fueled a rapid growth in amateur asteroid studies. Through it observers shared strategies, successes, and trying failures in the difficult art of tracking small solar system bodies across the sky.

In 1980, the International Astronomical Union bestowed the name JUGTA to asteroid 2136, a name comprised of Gunter's initials and the initials of his publication. He received other awards, including the 1983 Amateur Achievement Award from the Astronomical Society of the Pacific and the 1989 Caroline Herschel Award from the Western Amateur Astronomers.

Gunter gained great joy from his readers, and his production of *Tonight's Asteroids* was a labor of love. Many who had their interest sparked by him now carry his flame in pursuit of asteroid studies. — *Richard P. Binzel*

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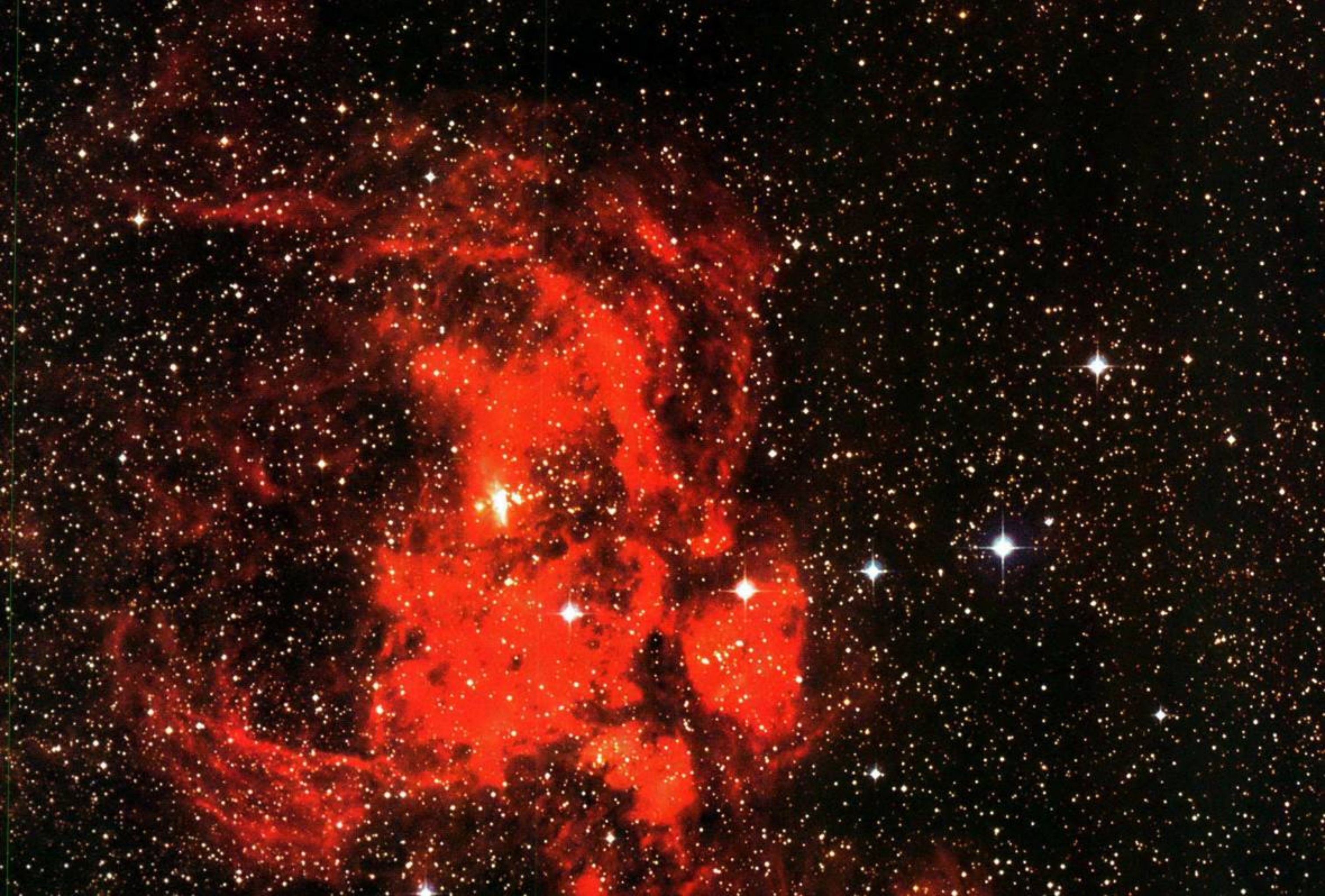
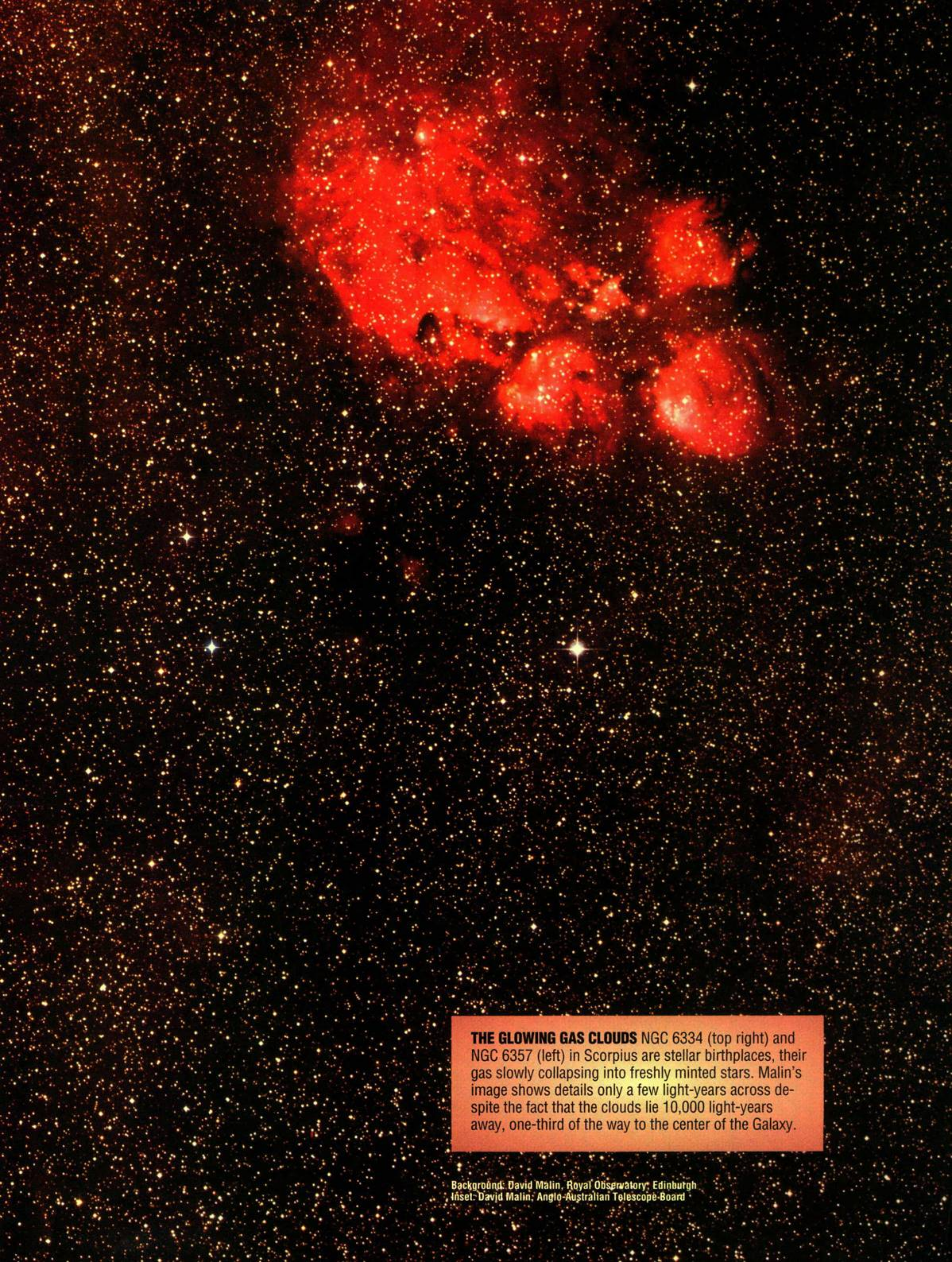
David Malin's Universe

A photographer-astronomer uses innovative techniques to create the sharpest and most color-rich images of star clusters, nebulae, and galaxies ever made.

by Peter Bond





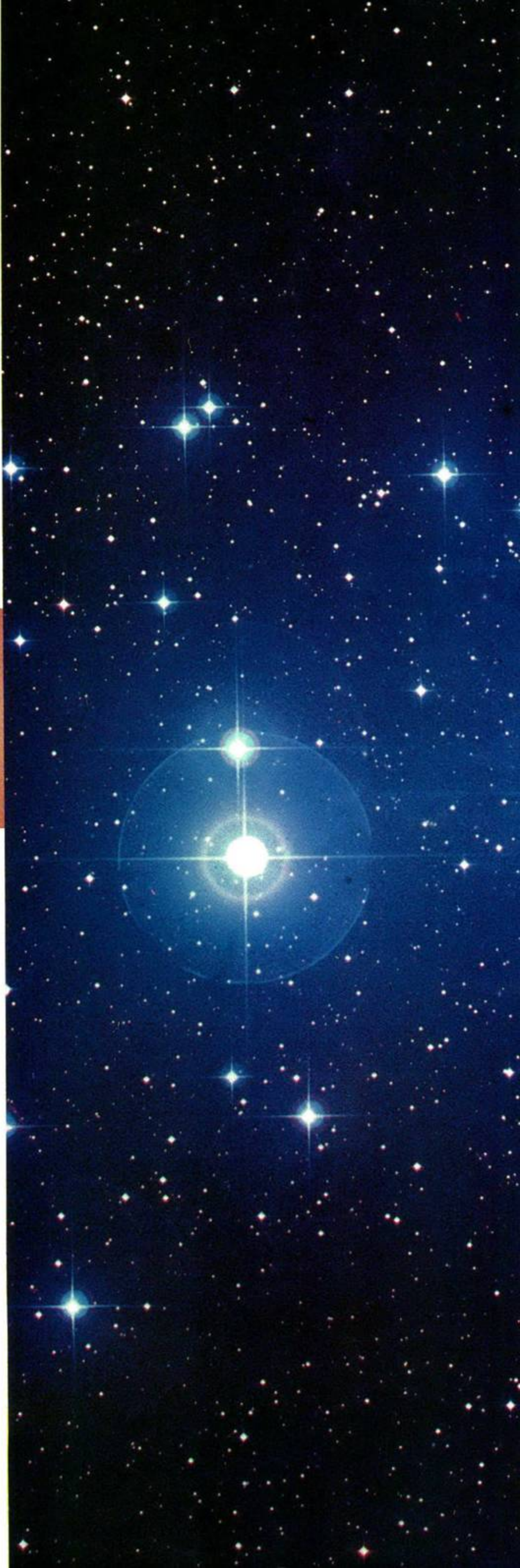
THE GLOWING GAS CLOUDS NGC 6334 (top right) and NGC 6357 (left) in Scorpius are stellar birthplaces, their gas slowly collapsing into freshly minted stars. Malin's image shows details only a few light-years across despite the fact that the clouds lie 10,000 light-years away, one-third of the way to the center of the Galaxy.

Background: David Malin, Royal Observatory, Edinburgh
Inset: David Malin, Anglo-Australian Telescope Board

Once, the universe was a drab, fuzzy place. Pictures of faraway galaxies and Milky Way star clouds lacked the sharpness and rich color that now splash across the pages of Astronomy. But a big change rolled through the darkrooms of professional observatories a decade or two ago. The man who led this imaging revolution is soft-spoken, British-born David Malin.

Malin, 54, of Sydney, Australia, is a photographic scientist at the Anglo-Australian Observatory in Siding Spring, New South Wales. His spectacular color photographs of celestial objects have revealed unprecedented detail in many star clusters and gas clouds in our Galaxy as well as others. The photos are the result of experiments with photographic techniques that continue to influence astrophotography.

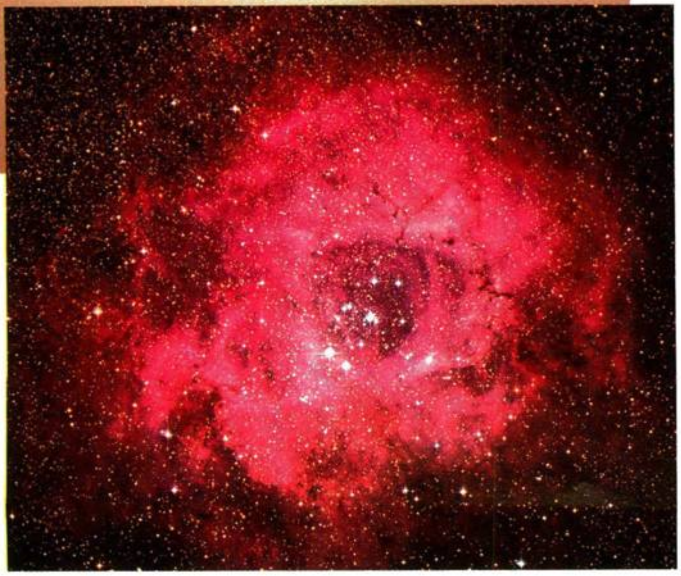
Introduced to photography at age 17, Malin became a scientific imager at the Swiss chemical company CIBA-Geigy in Manchester, England, producing photomicrographs of crystals. In 1974 he launched a new career by answering an advertisement for a photographic specialist to work on the new Anglo-Australian



David Malin, Royal Observatory, Edinburgh, and Anglo-Australian Telescope Board

THE SPARKLING PLEIADES CLUSTER, its intense blue color captured by Malin's tricolor technique, consists of about 100 stars spawned from a common gas cloud some 50 million years ago. The brightest blue-white stars splash light onto a thin cloud of dust that enshrouds the cluster and reflects the light to us over a gulf of 400 light-years. The cloud is a misty veil of dust grains with a typical size of those in cigarette smoke.

BLOWN AWAY BY HOT STELLAR WINDS, the gas once in the center of the Rosette Nebula has been pushed into a shell surrounding the brilliant cluster of young stars inside. Malin used tricolor photography with a large telescope to capture the ruddy color of the roselike wreath and minute details of dark nebulae twisting in front of the glowing gas.



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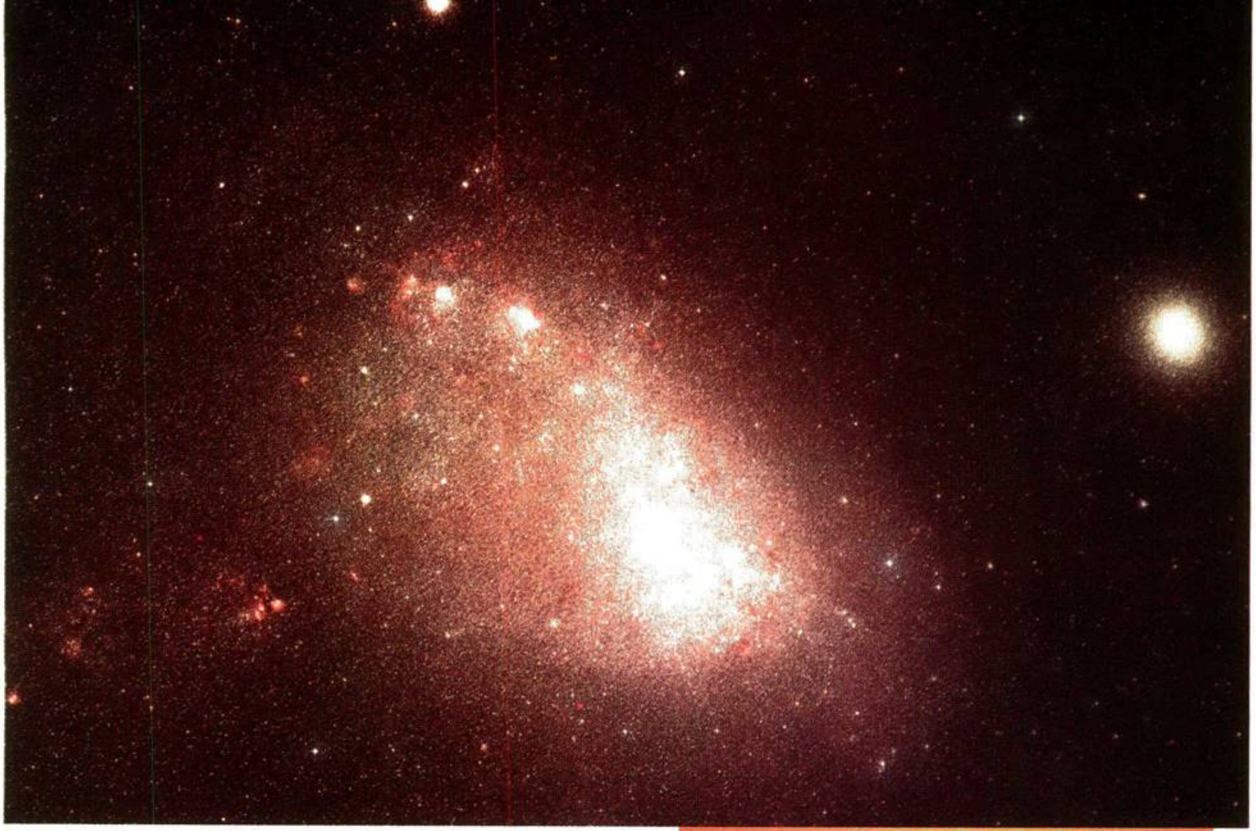
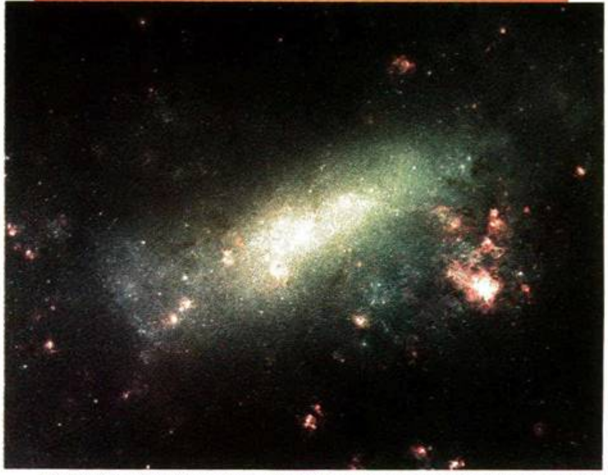


David Malin, Royal Observatory, Edinburgh, and Anglo-Australian Telescope Board

THE MAGELLANIC CLOUDS are small galaxies that orbit the Milky Way Galaxy. Malin's sharp, wide-field images show details in the Small Magellanic Cloud (top) and the Large Magellanic Cloud (below). The giant globular cluster 47 Tucanae, right of the Small Magellanic Cloud, is the second largest and brightest such cluster in the sky. The pink splotch in the Large Magellanic Cloud is the Tarantula Nebula, the largest star factory known, an object 30 times the size of the Orion Nebula.



David Malin, Royal Observatory, Edinburgh, and Anglo-Australian Telescope Board

David Malin, Royal Observatory, Edinburgh, and Anglo-Australian Telescope Board

Telescope. He knew nothing of astronomy at the time, but while at CIBA he had attended technical school, receiving a thorough grounding in chemistry, physics, and photographic techniques. These encouraged him to develop new ways of recording the sky.

Malin went to work with the 3.9-meter Anglo-Australian Telescope and the 1.2-meter United Kingdom Schmidt Telescope, also located at Siding Spring but administered by the Royal Observatory, Edinburgh. His first color images looked "washed out," so he decided to try some techniques learned at CIBA-Geigy: tricolor photography, photo amplification, and unsharp masking. Photographers had been using these techniques for some time, but Malin modified them for the challenges posed by astronomical objects.

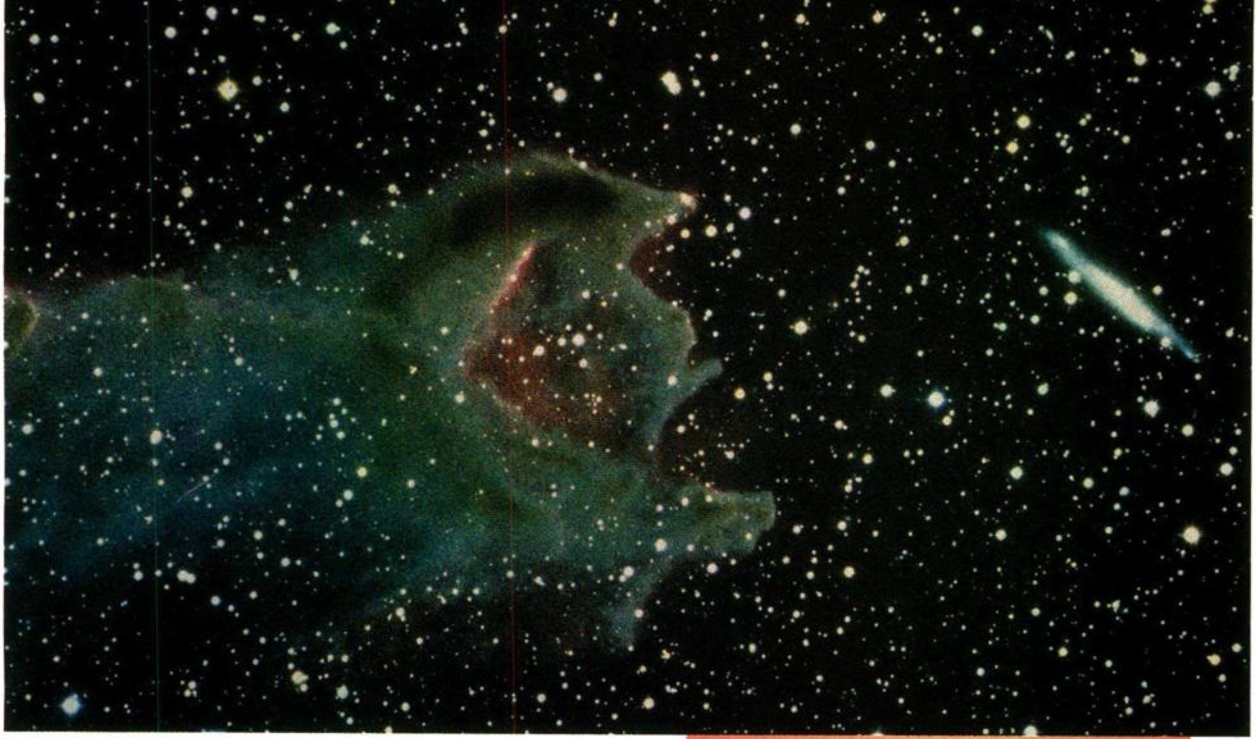
"Tricolor photography combines three plates shot on black-and-white film into a single image," Malin explains. "Each of the three plates captures a different color of light, using red, green, and blue filters, to produce color images that retain the sharpness of black-and-white films."

When Malin began using the tricolor process, it was unwieldy and complicated, but the efforts paid off big. In an instant the color images had something no color images of the sky had before: crisp details in nebulae and galaxies. Coupling filters with photographic emulsions sensitive to different colors of light, Malin produced portraits of sky objects that showed colors faithfully.

BRUSHED BY DUST AND GAS, central Orion contains the Orion Nebula (bottom) and the Horsehead Nebula (left, near top). The tricolor technique separates the colors and types of nebulosity in the field. Clouds of gas glowing by fluorescence appear reddish, while areas of dust reflecting starlight are blue. The tiny horsehead stretches about 6 trillion miles across, about one light-year.

The second technique, photo amplification, combines several exposures of the same area of sky to increase the contrast of faint deep-sky objects. It's like turning up the contrast knob on a television set. "Photo amplification allows you to extract the maximum amount of information from a plate," says Malin. The technique reduces the graininess of the image while it allows faint detail to show up with great clarity.

When doing unsharp masking, the third technique,



David Malin, Royal Observatory, Edinburgh, and Anglo-Australian Telescope Board

David Malin, Anglo-Australian Telescope Board

COMETARY GLOBULES are not comets but areas of glowing gas created by hot stars with ferocious winds. The winds shape the globules into comet-like apparitions with dense, glowing shells and dusty, empty "tails." Tricolor and image amplification bring out the colors and increase contrast. The greenish color in CG 4 (above) comes from dust that is absorbing some of the light reflected from stars. The large dusty globule below lies in Scorpius.

Malin superimposes positive and negative images of the same piece of sky to bring out details from overexposed areas of a galaxy or nebula. If the positive image is unsharp, or blurred slightly, it cancels the unsharp part of the negative and emphasizes the sharp details on the final print.

Together, these powerful techniques have led to the discovery of some celestial objects. "We had an image of M89," says Malin, "a boring elliptical in Virgo. I copied it at very high contrast to bring out some faint detail, and noticed this jet sticking out of it."

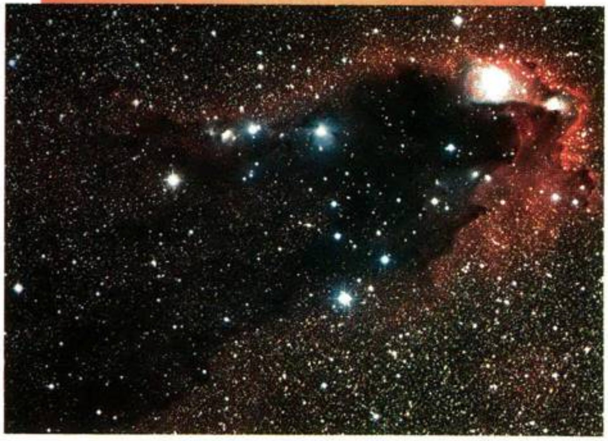
Besides the supersonic jet coming out of the nucleus of M89, Malin stumbled upon a dwarf galaxy now called Malin 1. This discovery came from a collaboration with astronomers Chris Impey and Greg Bothun. "I was adding together images of the Virgo Cluster and sending them to my colleagues," he says, "when I found one with an unusual nucleus." Subsequent observations showed the object was distant, far beyond the Virgo Cluster itself. It was an odd, unevolving galaxy.

While his photography has been of interest to academic research, Malin offers it to many groups interested in astronomical objects because he enjoys sharing his unique images.

"Astronomy has been a very important contributor to the way we perceive the world," he says. "Today, most people have an inkling that the Sun is a star, that there are billions of stars in the sky, and even that the universe is expanding. A few centuries ago that common knowledge didn't exist.

"This new understanding has changed our outlook on society as well as stars and galaxies. Astronomers have provided the raw information that's forced the change. I think the human race has benefited from astronomy and I'm proud to be associated with that." ☐

BLACK STRANDS OF MOLECULAR DUST snake across the glowing patches of red and blue nebulosity known as NGC 6559 and IC 1274/5 in Sagittarius. The tricolor technique produces an image where the nebulosity seems to float against the backdrop of stars and black voids. Ordinarily such dark *nebulae* would never be seen, but backlighting from glowing clouds exposes the dust, which makes up a fraction of the mass of our Galaxy.



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Peter Bond is a science journalist living in Cranleigh, Surrey, England. He frequently contributes news stories on space exploration and telescopes.

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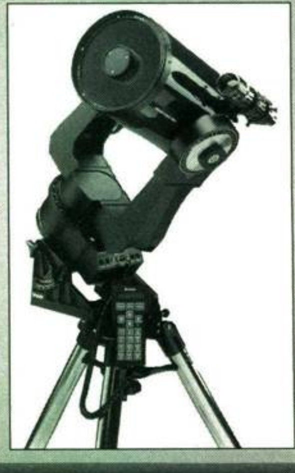

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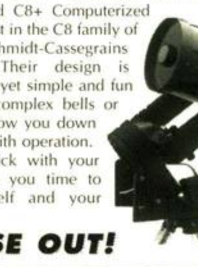

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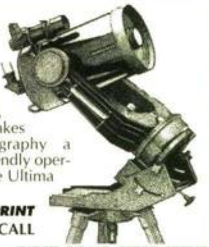

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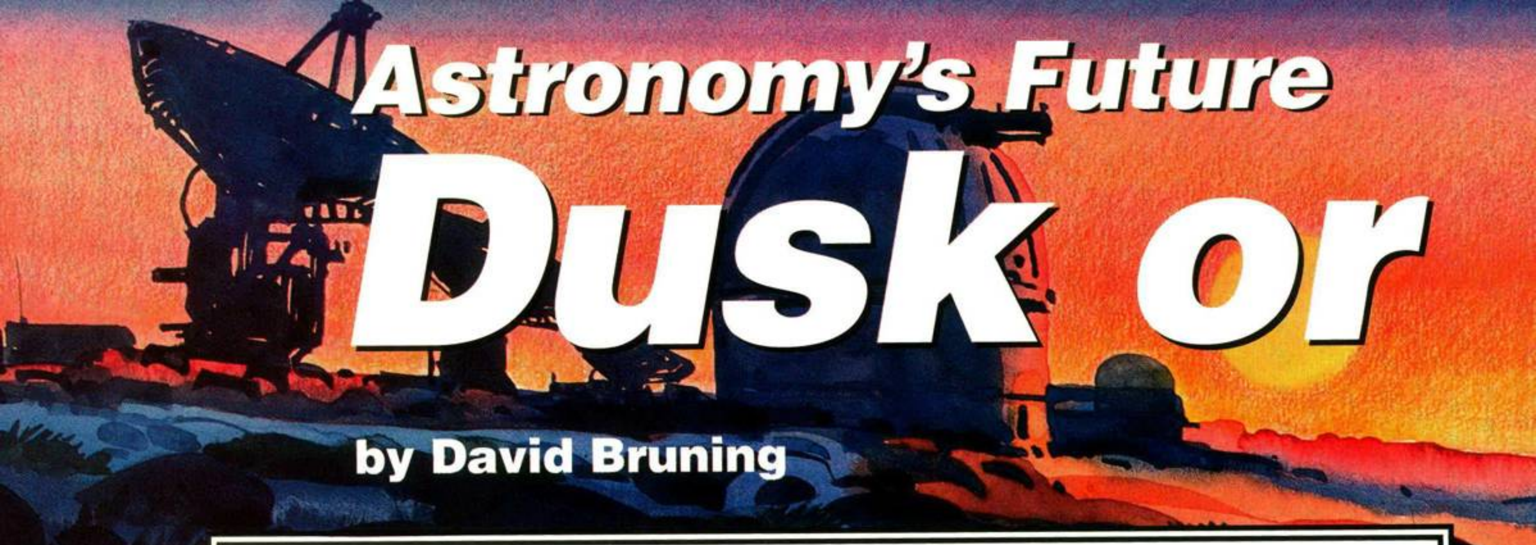


Astronomy's Future Dusk or

by David Bruning

Leadership in research. Telescope access for all. Those have been the watchwords of ground-based astronomy in the United States for the last 30 years.

But federal budgets over the last decade have increasingly undermined these guiding principles until at last, nationally funded observatories can no longer combine or reduce programs to balance their budgets. The nation's astronomers now must close programs and probably a few telescopes as they face still-decreasing budgets.

With a bleak future promising continued cutbacks, or at best level funding, can our national astronomy program continue to meet the goals of leadership and accessibility? Surprisingly the answer is yes.

"These are hard times," says Sidney Wolff, director of the National Optical Astronomy Observatories in Tucson, Arizona. "Yet they are exciting because they present new opportunities."

Some telescopes and research programs may soon close. But with a dose of cleverness, astronomers may be better off.

Knowing When to Fold 'Em

Although closing scopes is painful and will affect current research programs, many astronomers are considering sacrificing well-worn programs in favor of new projects that promise cutting-edge results. But the sacrifices provide an opportunity to push forward with new technologies and observing schemes not possible with some older scopes.

NASA managers have already wrestled with this problem in NASA's airborne astronomy program. The Kuiper Airborne Observatory was a C-141 airplane that carried an infrared telescope to altitudes of 40,000 feet. (See "Telescopes That Fly," November 1994.) For 20 years, it produced many discoveries and acted as a testbed for new infrared instrumentation. But NASA's budget woes forced the agency to mothball the flying observatory. The savings over the next five years will enable them to launch a new program called SOFIA, the Stratospheric Observatory for Infrared Astronomy.

Instead of stopping an avenue of research altogether, NASA has just postponed it. Closing Kuiper will impact many astronomers' current research projects. But it was getting old. Maintenance of the aging plane was expensive and the observatory's 36-inch scope was limited in its light-collecting ability. SOFIA will boast a 100-inch telescope that will do science only dreamt of with Kuiper.

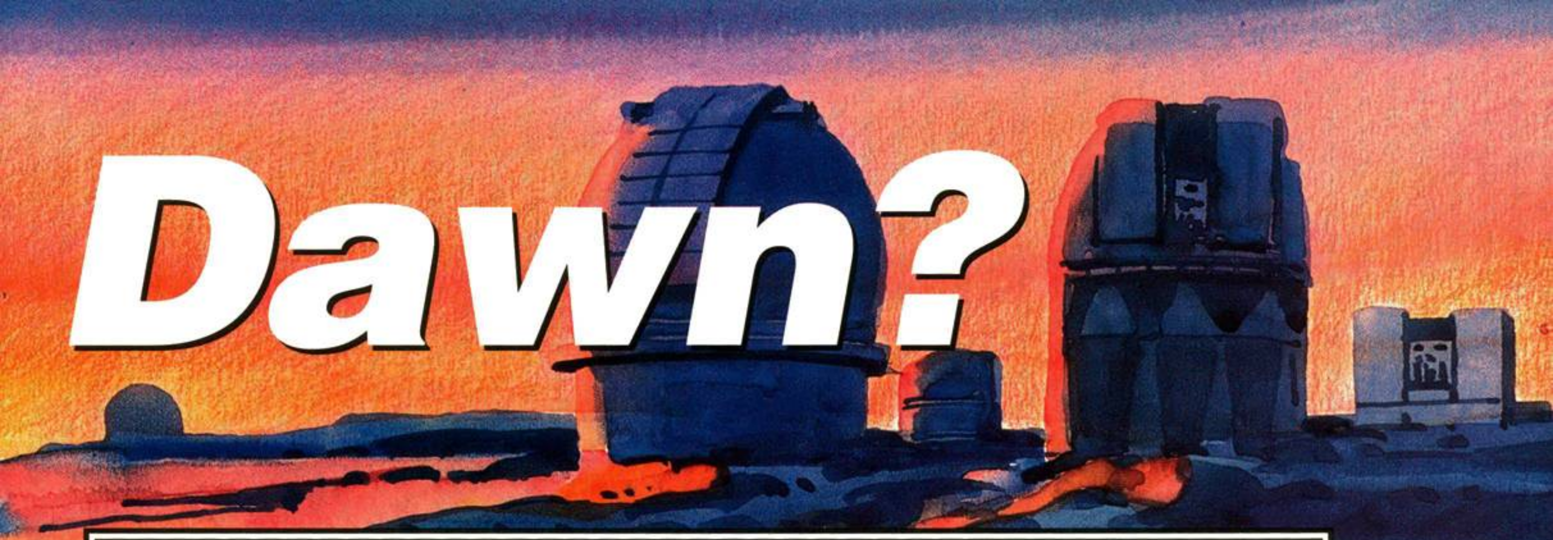
New Vision

Within ground-based astronomy, it isn't clear yet which programs must be sacrificed or postponed so others can go on. Clearly one of the programs that will be hardest hit is the national observatories.

The National Optical Astronomy Observatories consist of Kitt Peak National Observatory south of Tucson, Cerro Tololo Inter-American Observatory in Chile, and the National Solar Observatory, with sites on Kitt Peak and Sacramento Peak in southern New Mexico. NOAO's budget has largely remained level over the last decade, but inflation has eroded the observatories' buying power by 30 percent. Add to this a much larger inflation rate in Chile and the observatories have really lost financial ground. Recently they had to absorb another blow — a 6 percent cut in their budget (including inflation) when the National Science Foundation implemented the 1995 budget. (NSF at the same time provided $2 million to offset costs of permanently lowering NOAO's operating budget.)

Unfortunately as the observatories' scopes age, they require more maintenance and more money to adapt them to new technologies. Some need renovation to make them competitive with newer scopes. But the cost of maintenance is eroding NOAO's ability to develop new instruments and scientific programs and rules out the building of new scopes to meet the demand for observing time.

The observatories, despite heroic efforts to run programs on less money each year, are finally losing the battle. The talented NOAO staff has run out of



Dawn?

alternatives. This year's cuts — and possible additional cuts next year — mean that drastic measures are necessary to salvage a productive observatory that can meet the challenges of astronomical research in the 21st century.

NOAO has no more notches in its belt to tighten. It has run out of projects and programs to cut. Now it needs to close scopes and possibly observatory sites and lay off some of the same hard-working staff that has made the observatories run smoothly this last decade.

One of the groups grappling with this double-edged sword of reduction and opportunity for NOAO is the Panel on Ground-based Optical and Infrared Astronomy headed by Richard McCray of the University of Colorado in Boulder. The National Research Council, at the request of the National Science Foundation (which funds ground-based astronomical research in the United States), formed the panel and asked it to prioritize the nation's optical and infrared programs assuming several different pictures of future funding.

> **"These are hard times. Yet they are exciting because they present new opportunities."**

First the McCray panel considered funding continuing at a constant level and suggested a course of action: concentrate on the country's unique programs and sacrifice the rest. They identified the unique programs as the U. S. Gemini Project (twin 8-meter telescopes being built in Hawaii and Chile), the large telescopes at Cerro Tololo, and instrument development around the country. To provide sufficient funds for these high-priority programs, the panel recommended reducing the scientific support staff at NOAO and closing the small scopes on Kitt Peak.

Exacerbating the funding difficulties is the $5.5 million needed to run the Gemini scopes. (First light for the Mauna Kea scope will come in 1998 and in 2000 for the Chilean scope on Cerro Pachon, but the full $5.5 million won't be needed until after 2002.) This would come out of the NOAO budget and amounts to half of the current Kitt Peak budget or all of the Cerro Tololo budget.

In this level-funding plan, the 4-meter telescope on Kitt Peak, its largest, would remain open. But it would have fewer instruments than it does now and the number of astronomers using it would possibly decrease to maximize scientific results instead of astronomer accessibility. In fact, the panel suggests that the 25-year-old scope's maintenance (and that of the 4-meter scope at Cerro Tololo) is so expensive that it might be better to build a new scope using modern technologies. The savings in maintenance would pay back the $12 million cost of a new-technology telescope with a 4-meter aperture in about 20 years.

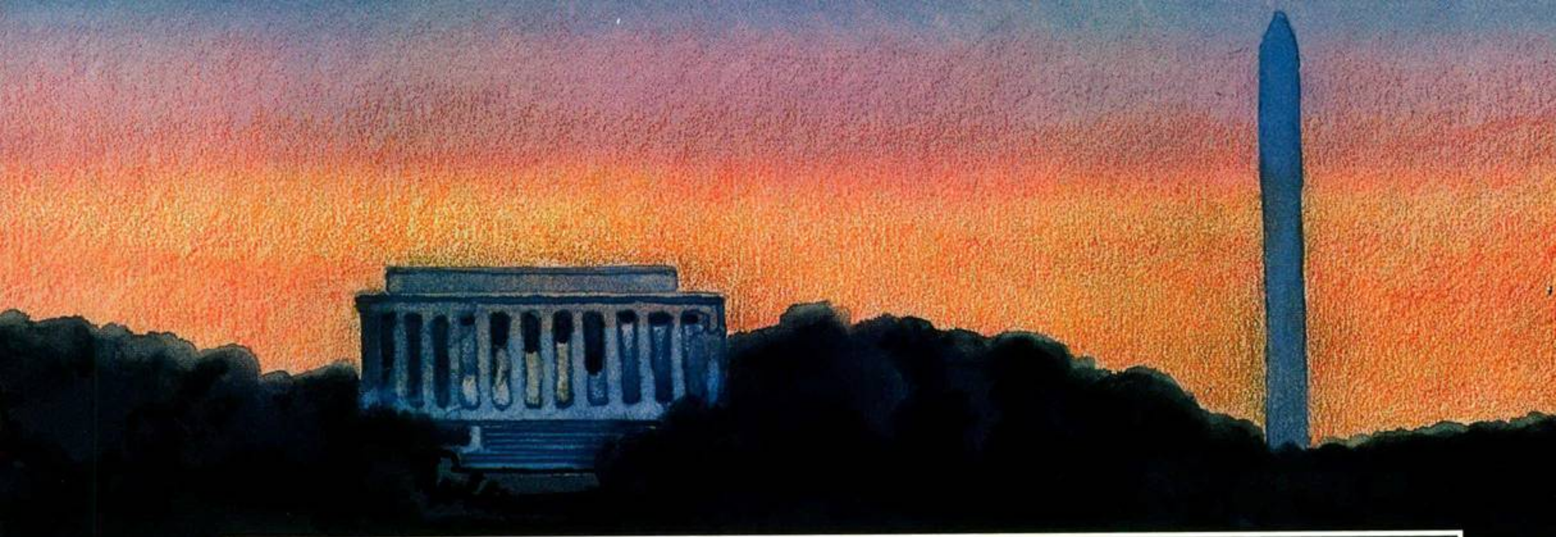
Under this system, hard choices will have to be made that will change the types of astronomy done by researchers. Many good programs will be cut and access to top-notch observatories may again become restricted as it was before 1960 when the national observatories opened to provide access to first-rate equipment for all astronomers.

In the austerity of the nineties, the question is whether post-Cold War federal budgets can continue to provide research access to all scientists. Knowing that his response will not be popular, Richard McCray says that "the goal should be to maximize science, not maximize access to telescopes for all astronomers."

Some relief would be possible if the operating costs of the Gemini telescopes don't come out of the level funding budget. The panel says a better solution would be to increase the budget by $10 million. That would include $5.5 million for Gemini and leave enough to build a new generation of instruments that would keep U.S. astronomy at the cutting edge of research.

Under this augmented plan, new scopes could be built to replace aging instruments. But even with an increased budget, economies will be necessary because astronomy has lost so much ground over the past decade. The panel says that it's time for astronomers to learn what other scientific communi-

Bruce Bond



ties have learned: They must retire older facilities to make room for new state-of-the-art facilities.

As this article went to press, McCray learned "that NSF has made a commitment to provide the additional $5.5 million for Gemini operating costs. Things look better now than when the panel made its report."

Bigger than Before

It's ironic that as astronomers talk about closing programs and telescopes they also will enjoy more aperture than ever before. In the next decade, the total light-collecting area of large scopes will increase by almost 2½ times.

Most of these scopes will be in the hands of private colleges and universities that don't have to share the facilities with outside astronomers. So even though there will be more large scopes, access to them will remain limited.

> **"The goal should be to maximize science, not maximize access to telescopes for all astronomers."**

But the McCray panel has an idea for increasing access to large scopes. In exchange for federal funds for developing new instruments, private observatories would provide access to their telescopes to outside astronomers. The directors of the private observatories are already studying plans to see how this scheme might be implemented.

New instruments on older scopes will also permit cutting-edge research. Optical assemblies that compensate for atmospheric turbulence will soon routinely show details now seen only by the the Hubble Space Telescope. New infrared arrays can image 300 times the amount of sky imaged by the same scope five years earlier. And new multiobject spectrometers can obtain the spectra of 100 galaxies in the time a previos spectrometers took only one. So the McCray panel's priority of new-instrument development is clearly an important one.

Out of Step

Several difficulties exist with the McCray panel recommendations. First, they have looked at various funding scenarios for the next decade. But unfortunately NOAO receives its funding on a yearly basis.

Normally the National Science Foundation allocates funds for university research programs for three to five years. The irony is that these projects are often flexible and can make short-term budget corrections but NOAO is a financial battleship that can't respond to midyear budget cuts. Cutting staff often requires 5-months severance pay for U.S. astronomers (12 months in Chile). So mid-year reductions in staff actually don't save much money. The Foundation should allocate funds to NOAO for a three-to-five year period.

One can also question the narrowness of the charge given by NSF to the McCray panel. At NSF's request, the panel dealt only with ground-based optical and infrared astronomy. Yet placing each area of astronomy into separate boxes is no way to set priorities for all of astronomy. The committee looks at a single box of fixed size, yet astronomers may need to reset priorities among the different boxes of astronomical research or even get rid of a box so others can survive.

The Foundation should look at how it funds NOAO and astronomy as a whole to better permit astronomers to plan for the future. As the fabric of astronomy changes in this country so should the methods that fund the science.

A New Way of Looking

With the emphasis on maximizing scientific results, astronomers are starting to look at how they use scopes. For example, instrument changes are expensive on older scopes because they require a work crew to dismount one instrument, mount the next instrument, rebalance the scope, and calibrate the new instrument. So observatories are looking at ways to reduce instrument changes, including building scopes dedicated to one type of observing.

Another source of waste is having astronomers fly to the observatory to do the observing. In many

cases, the observatory staff are more knowledgeable users of the scopes and could do an equally good or better job of observing and do it more efficiently. Also service observing by observatory staff would allow research money to be spent on data analysis instead of travel costs.

Todd Boroson of the U. S. Gemini Project Office has studied different observing modes for the large scopes: classical observing, whereby observers go to the observatory, and queue observing, whereby observatory staff do the observing. Boroson considered 60 observing projects, each with different needs for sky conditions, instruments, and amounts of observing time. Each project received a grade indicating its scientific merit and technical feasibility.

In the classical scheme, the grades only determine which projects receive time on the scope. After that, the grades become unimportant because each observer has his or her slice of time. But if those nights are cloudy, too bad — the astronomer has to reapply for observing time. If the weather is great and the astronomers complete their goals in the first of three nights, the remaining nights can't be used by other astronomers because they haven't gotten to the observatory yet.

In queue observing, each proposal's grade establishes its priority in the queue. With the help of a scheduling computer, the staff astronomers juggle sky conditions, equipment, and proposal grades to choose which project to run during each time slot. A night may start out perfect for imaging, so the top imaging proposals get in line and the observers crank out a number of images. Around midnight the seeing may go bad. The observers switch to the spectrometer (easy to do on a scope like Gemini because the instruments are permanently mounted and designed for rapid changeover). Instead of wasting the second half of the night, the observers now crank out spectra for the highest priority proposals.

Boroson's projections show that the classical scheme, regardless of grade, completes about half of each proposed project. But the queue system completes almost 100 percent of the top proposals. This system maximizes the science because the best projects get completed. In fact, 67 percent of all project goals are met compared to only 43 percent under the classical system.

Of course some projects can't be done by queue observing, and time is needed for instrument development. So to start, Gemini will schedule about 50 percent of the scope's time as queue observing and the other half as traditional on-site observing. The mix may change as astronomers adjust to the new system and learn to schedule time in this new way. Other observatories are looking at this system to increase their productivity.

As the fabric of astronomy changes in this country, so should the methods that fund the science.

Some observatories are taking the reduction of on-site observing a step further by using robotic telescopes. These scopes are automated so astronomers don't need to be present. Instead they use the electronic superhighway of the Internet to operate the scope from their home unversity — or even from home.

Dusk or Dawn?

Astronomy is undoubtedly going to change during the next 10 years. Some telescopes will likely close and research directions in astronomy will shift. The faces behind the computers and telescope control panels will change too.

But with all the new giant scopes being built, astronomers will have the ability to see more than ever before. With some judicious planning, they should have enough money to build state-of-the-art detectors and instruments for their studies. And new observing methods may increase the amount of science done by 50 percent or more.

So for the most part, astronomy's future is dawn. Astronomers are facing the difficult budget conditions and still managing to build for the future so the next generation of researchers will be able to exercise their curiosity about what's out in space. □

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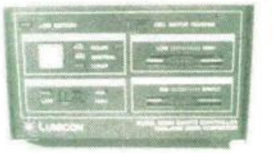

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Fuji HG400 fine grain color neg.	**24**	**$14.95**
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Operate your telescopes ***anywhere!*** Use the single-axis Unitrak with a 12V DC car battery. The dual-axis drives are for photography and use either 12V DC or 125V AC.

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NOW ONLY
$99.50

LUMICON Rich-Field Viewer on C-8 with LUMICON 2'' star diagonal and 2'' eyepiece.

The LUMICON Rich-Field Viewer fits **all** commercial Schmidt-Cassegrain telescopes. It has a high-performance coated achromatic focal reducing lens with 50mm clear aperture for **totally unvignetted viewing** with 2'' or 1¼'' eyepieces. It is available in several combinations depending on the eyepiece and field-of-view you desire (see chart below).

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†Includes 2'' enhanced aluminum Star Diagonal (may not reach focus on some telescopes).

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2⅛''	**2/$20**	15.6'', 16''*	**$28**
5½''	**$6**	19'' (DS-16)	**$35**
*Fits Odyssey		21'' (Odyssey-II)	**$35**

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8'' LX200
$2495

16'' LX200 $14,950

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LX100 - includes wedge, best for photography.
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NOTE: A wedge is **not** needed for visual observing with the LX200 Drive. Select f/10 or f/6.3 (no extra charge) for your Schmidt-Cassegrain.

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PHOTOGRAPHY ACCESSORIES

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8'' f/6
$699*

New 8'' f/6 Meade Starfinder telescopes

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6'' **f/8 Dobsonian Starfinder** ($46 P&S)	**$325**
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*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated packing & shipping charge to the price. Slightly lower P&S for payment by check. LUMICON showroom prices are $99 higher.

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LUMICON SKY VECTOR FEATURES:

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Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.

Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

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Coma 1 inch off-axis 17½'' f/4.5

Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2'' lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2'' EASY-GUIDERS for effortless installation.** This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8''.

LUMICON 48mm Coma Corrector/Field Flattener Lens	**$285.00**
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2'' Adapter for Pentax 6X7 ...	**$129.00**
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2'' Extension for viewing ...	**$26.00**

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1.8x Multiplier Lens (2'' Barlow)

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Protect the optics of your 8-14'' Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

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LOW PROFILE FOCUSERS New! Thread-on for Odyssey

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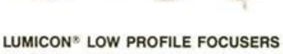

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LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½'' above the telescope tube. Use the 1¼'' or 2'' versions for viewing. Use the 2'' non-rotating focuser for convenient photography with the LUMICON 2'' EASY-GUIDER™.

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**Threaded to hold 48mm filters.*

South African Comet Crash Diary

With tons of gear and a small fortune in video equipment in tow, this group of amateur astronomers set out to record the event of a lifetime.

By Chris Stewart

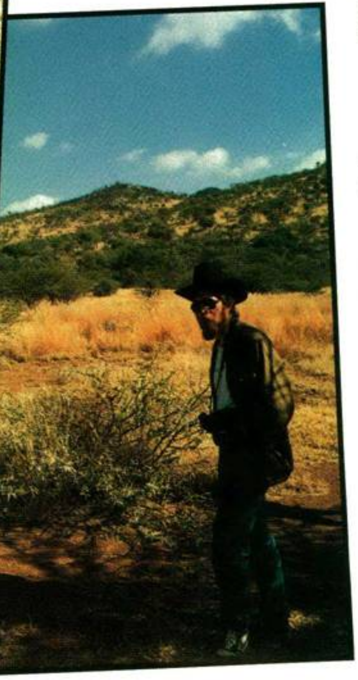
Jupiter takes a beating

All photos by Chris Stewart, unless noted

Readying the 60-inch

Comet crash team

A. Frans



The author explores the bush near Boyden

Boyden Observatory

While most of you remember the Great Comet Crash of 1994 together with humid summer evenings, we South Africans saw it during the cold and blustery weather of midwinter.

It was during the winter of '94 that our astronomy club mounted an effort to share Shoemaker-Levy 9's epic crash with our countrymen. Through bargaining and bartering, we pulled off a live broadcast on national television. During all the hustle and bustle, I kept a journal, a remembrance of a crash seen 'round the world and, in case you were wondering, well witnessed by most South Africans.

Friday, 16 July 1993,
One year before the crash

The news is electrifying: Jupiter has captured a comet, broken it up, and set it on a collision course with the gas giant. Nobody really knows what humans will see when the crash happens. Speculation ranges from "nothing" to "the formation of a Saturn-like ring system." This uncertainty does nothing to help resolve the real question of how best to observe such a truly epochal event.

We at the Transvaal Center of the Astronomical Society of Southern Africa (ASSA) are blessed with a membership that has a high level of expertise and good observing equipment. After much discussion we decide to show the upcoming comet crash to the public in hopes of promoting astronomy in particular and science in general. But public viewing sessions are accessible to only a small number of people. One person perched atop a ladder peers through an eyepiece and exclaims "Gee, you should see this!" to which those milling about on the ground respond "What? What?" while the observer continues, "Well, I don't know, it's kinda hard to describe . . . but it's gone now."

How can we involve everyone in the crash? Well, we are fortunate that the crash happens at a time when science allows us to predict it and plan ahead to observe, and the technology is there to share it.

For the past few years a member of our group has been experimenting with video astronomy, using a CCD-based video camera developed for the security industry. The images he gets through his vintage 8-inch SCT are quite good. Since such cameras have been improving dramatically, we set about getting our hands on newer cameras from some companies in South Africa. The plan is to share video with the public while recording the crash on tape.

Then there's the matter of what scopes we can use. Boyden Observatory in Bloemfontein is effectively mothballed, the victim of professional optical astronomy's being consolidated elsewhere in South Africa.

But Boyden still has a 60-inch Cassegrain, a 16-inch Cassegrain, and a 13-inch refractor, all in operable condition. It would be a shame if the observatory stood idle while the comet crash was in progress, particularly since the 60-inch primary mirror has recently been realuminized. So negotiations begin, and without too much persuasion the University of the Orange Free State (UOFS) kindly agrees to make Boyden available to us.

With this key element in place, our comet crash countdown proceeds in earnest.

Wednesday, 8 June 1994, five weeks before the crash

The "Jupiter Impact Group," as we've dubbed ourselves, shares its plan at a meeting of the Transvaal Center. We present a wish-list of equipment and explain how a video color camera would be a good match for the 60-inch. But we don't even have 10 percent of the equipment we'll need, let alone a suitable camera, and time is slipping by at an alarming rate. Our appeals for people to volunteer equipment and assistance meet with little response. Obviously, nobody at the Center has access to the stuff we need: It's time to get seriously creative.

Tuesday, 28 June, two weeks before the crash

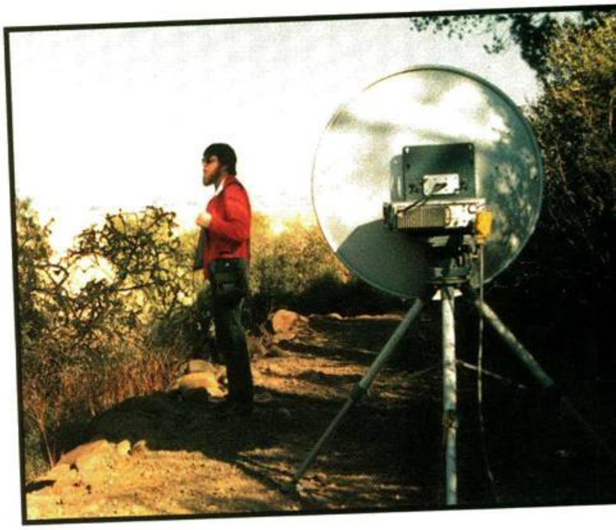
Some progress is finally evident. We manage to obtain suitable color and monochrome cameras from a security installations company. Via a member of ASSA's Pretoria Center, there is a promise of a professional 3-chip high-resolution color CCD video camera with suitable sensitivity.

Frantic telephone conversations to Bloemfontein have the UOFS stripping off an instrumentation case from the 60-inch and machining a 2-inch focusing tube to replace it. All night workshop sessions produce the 2-inch adapter and bayonet mount for a professional video camera we hope to borrow. We arrange to provide the national television service with images in exchange for the use of some of their equipment and access to additional machining facilities.

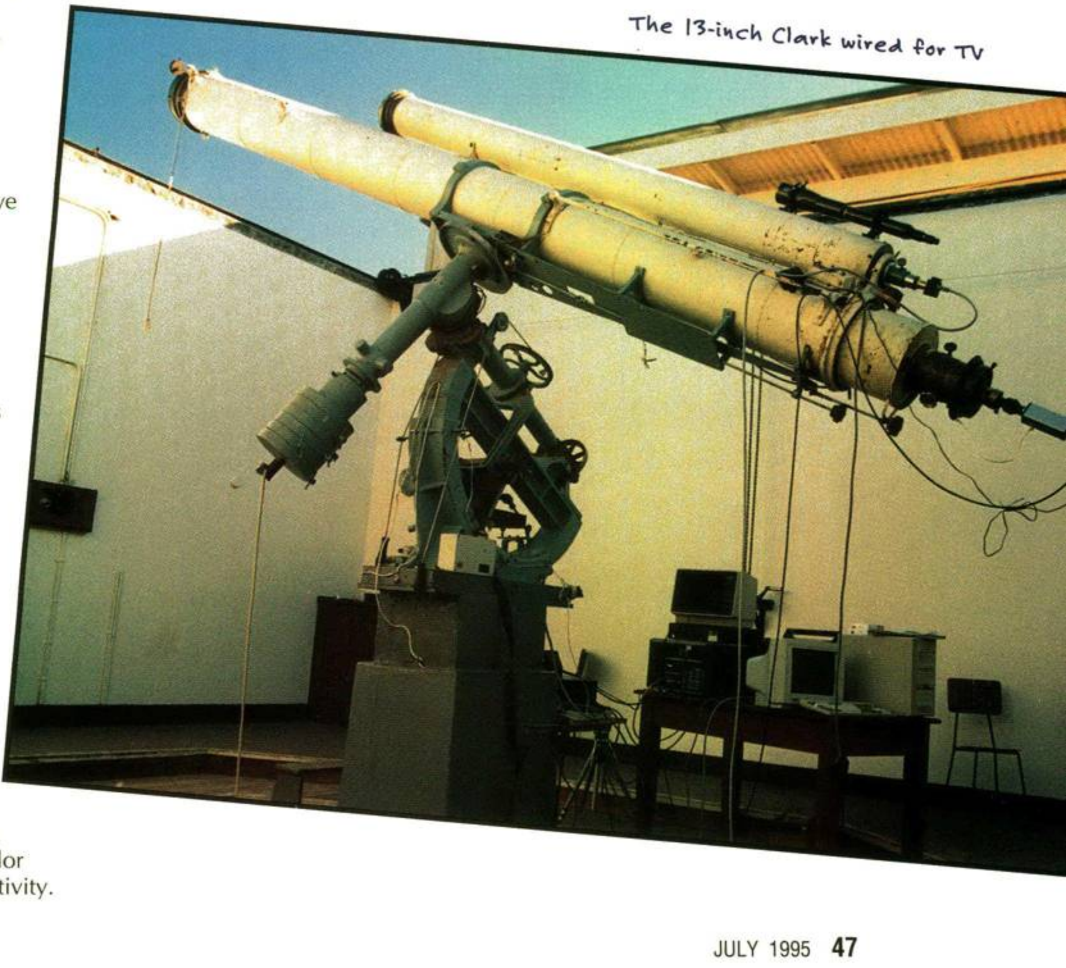
A supermarket chain, despite being in the midst of a strike action, volunteers to provide catering for a cheese and wine party we're holding on the night of fragment A's impact. Companies in Bloemfontein loan video projectors and computer equipment that can grab still images from video. An import company donates some 120 hours worth of new VHS cassettes.

Sunday, 10 July, six days before the crash

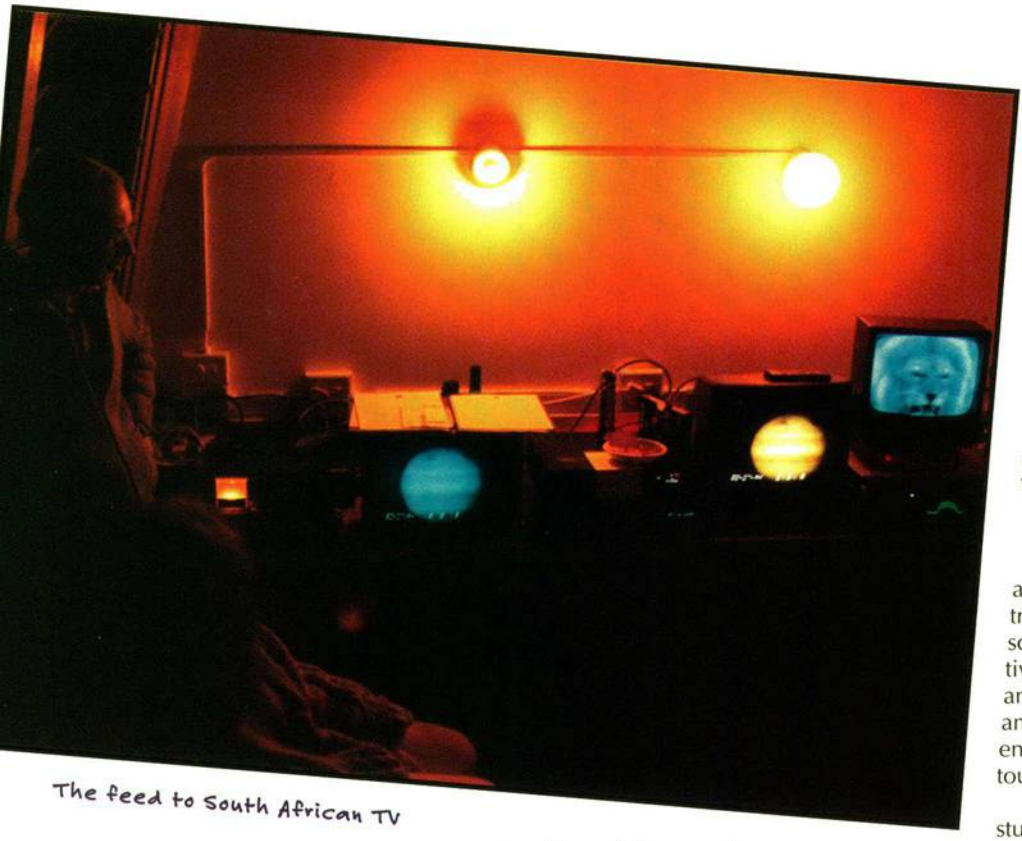
Three of us and two representatives from the TV service visit Boyden for an equipment check. This turns out to be beneficial: The 2-inch adapter tube doesn't screw in far



Setting up a TV relay



The 13-inch Clark wired for TV



The feed to South African TV

enough to achieve good focus and requires further work. The focuser on the 13-inch refractor turns out to be too small and needs to be machined to take 1.25-inch equipment. (Since the instrument is over 100 years old, this is not surprising. But Alvan Clark deserves applause for fantastically good optics that have stood the test of time.) The two cameras brought by the TV crew prove inadequate for the task, but our three function fine.

P. Pienaar

Breaking for lunch

Tonight a cold front comes over, bringing with it clouds and temperatures of –9° C (16° F) before wind chill. We plot where in the observatory video cables will run and then retire to a nearby holiday resort to eat and sleep, using the stove's oven to warm the bungalow!

Monday, 11 July, five days before the crash

We return to Transvaal to continue our preparations, praying that the weather will improve. The rest of the week speeds by, with utter chaos and panic situations seemingly the norm. We hear it has snowed in Bloemfontein. We're not sure if we can pull this off, but somehow right at the last moment, maybe all the critical elements will coalesce.

Friday, 15 July, one day before the crash

Despite car troubles en route, an advance party makes it to Boyden and starts setting up. The flu comes along just to make life interesting. Several members erect a radio mast with a long inverted-V antenna on the flat roof over the entrance to the 60-inch and set up radio equipment in the control room. This will allow us to keep in touch with other amateurs across the country via radio. Care is taken to ensure that the antenna mast clears as the dome and its vertical shutter rotate. We install numerous power, video, and radio cables between the telescope, control room, and radio mast. Nonetheless, at the end of the day, pitifully little seems accomplished and the flu seems worse. At least the weather is cooperating.

Saturday, 16 July, crash day

The day of our dreams dawns bright and clear. The rest of our core group trickles in, bringing with them more telescopes and lots of equipment. Representatives of UOFS, ASSA's Bloemfontein Center, and the media, plus equipment suppliers and quizzy members of the public descend en masse. The telephone is warm to the touch from all the calls we field.

As dusk descends, the 60-inch produces stunning images of Jupiter that almost fill the screen. A video feed to the hall lets the public see live images during lectures. During the cheese and wine party, guests liberally toast the comet. Apart from viewing the video images, people look through the observatory's 13-inch and 16-inch, as well as through 8-inch and 10-inch homemade and commercial amateur scopes.

Our center's chairman is interviewed live by the international news media. The predicted impact time comes and goes with no visible effects, and he is forced to tell South Africa and the world that the crash appears to be a grand non-event. Boy, was this statement to be proven wrong!

Seemingly, half of Bloemfontein is queuing at the gates; unfortunately security personnel are forced to turn back scores of hopefuls wishing to join us. Boyden has probably never held such a crowd since construction was completed in the 1930s.

The supermarket offers to provide more wine and cheese for the expected big event, the impact of Q on Wednesday, July 20. Via radio, we make contact with a group north of Johannesburg that has built a radio telescope. They report receiving a large burst at the time fragment A hit. Buoyed up by excitement and alcohol (flu disregarded) we crawl into bed at 4 a.m. in a state of euphoria.

Sunday, 17 July, day two

We awake happy, but then disaster strikes. During routine tests, electronics that control the 60-inch fail, preventing us from slewing or tracking. Following a period of anguish, someone reaches a vacationing technician and convinces him to fix the

Where the wild things are

I suppose there are people in America who still think we ride elephants down the main roads of Johannesburg and keep leopards as pets. I mean, after all, aren't all Americans professional cowboys who allow longhorns to graze in backyards?

While some South Africans may own leopards, the sad reality is that Africa has just about been completely tamed and the wildlife has to be protected for it to survive. Most South Africans get to see wild animals only in a zoo, though there are many excellent wildlife preserves where it is possible to go hiking in the bush. Still, when we go out at night to observe, we do experience unusual things.

As always, the insects are the kind of wildlife we always have to contend with. One beautiful, balmy morning, with the air as clear and stable as I have ever encountered, I was enjoying a spot of planetary observing when I felt a tickling sensation on my arm. Absently rubbing at it, I then noticed my hand felt sticky. Glancing down, I saw that a huge swarm of mosquitoes had silently descended upon me and were in the process of reducing me to a desiccated husk. End of observing session.

A few years later, in July (our winter), a group of us decided to spend an observing weekend in the Pilansberg Game Reserve near Sun City in Bophuthatswana. After night fell, I set up the scope in a clearing that was both away from the campfire and offered a large chunk of sky, but not so far that I couldn't tap power from our vehicle to run the scope's drive. Every now and then, because I was separated from the group and the campfire, I would shine the torch (Americans call 'em flashlights) around the clearing to dissuade any night life from approaching.

It turns out they knew exactly where I was.

Everywhere my torch shined, eyes reflected light back. Most of them were green, but the eyes of nagapies (mammals otherwise known as bush babies) were an amazing orange. They looked weird, but at least I knew the critters were harmless.

Aside from animals that try to snatch a bit of sleep, there are snakes, spiders, and scorpions that notice the nocturnal ambling of observers. Venomous creatures generally stay away from amateur astronomers, but occasionally our paths do cross.

Recently, a ringhals, a member of the cobra family, had to be dispatched out at our observing site near Roodepoort. This was accomplished by the guy who spotted it: He dropped a heavy counterweight from the top of a nearby building. One needs to be circumspect around these snakes; they can spit venom in one's eyes with deadly accuracy.

Roodepoort also seems to be a favorite haunt for Button spiders (Americans know them as Black Widows). Thankfully, they prefer to live outdoors. If you just ignore them, they won't bug you — most of the time. One night after a particularly cold observing session, I crawled into my warm sleeping bag. Later that morning, a friend pointed out a spider that had found my bag just as inviting. I suppose that just like me, it also wanted to be warm.

Keeping warm around the fire

Like many of you, I try to mix family vacation with astronomy. My wife and I have a timeshare week at Mabalingwe Spa near Bronkhorstspruit, about an hour's drive north of Pretoria. I pack my 10-inch Schmidt-Cassegrain telescope and usually get in a couple of good nights of observing.

One nice observing site at the spa is the tennis courts, good because they are level and fenced in, which protects one against the molestations of wildlife.

Leopards occasionally roam this area, but it is the baboons that worry me more. One hears strange noises around the site at night, which can be a bit spooky. I have never seen anything untoward when shining the torch round, but all the same, baboons are very territorial and come equipped with sharp, pointy teeth.

P. Pienaar

Large Magellanic Cloud over Mabalingwe Spa

So what does a South African observer see besides the occasional token wildlife? In the north I see your favorites: the Dumbbell (M27), the Veil, the Helix, Cone, Eagle (M16), and Omega (M17) nebulae. But one popular object only manages to skirt my northern horizon: M31, the Andromeda Galaxy.

Of course from my vantage point, all those magnificent southern objects northern folks envy pass overhead: Eta Carinae, the Tarantula, Crux's Jewel Box star cluster, and the wonderful globular clusters 47 Tucanae and Omega Centauri.

If you ever get the itch to observe from the Southern Hemisphere, the far Southern Hemisphere, do consider looking up a chapter of the Astronomical Society of Southern Africa (ASSA). This umbrella organization includes clubs in South Africa, Namibia, and Zimbabwe. The society is divided into "centers" located in major cities like Johannesburg, Harare, and Cape Town. Our group, the Transvaal Center, would be more than willing to give any wayward northerner a tour of our skies. — *C. S.*

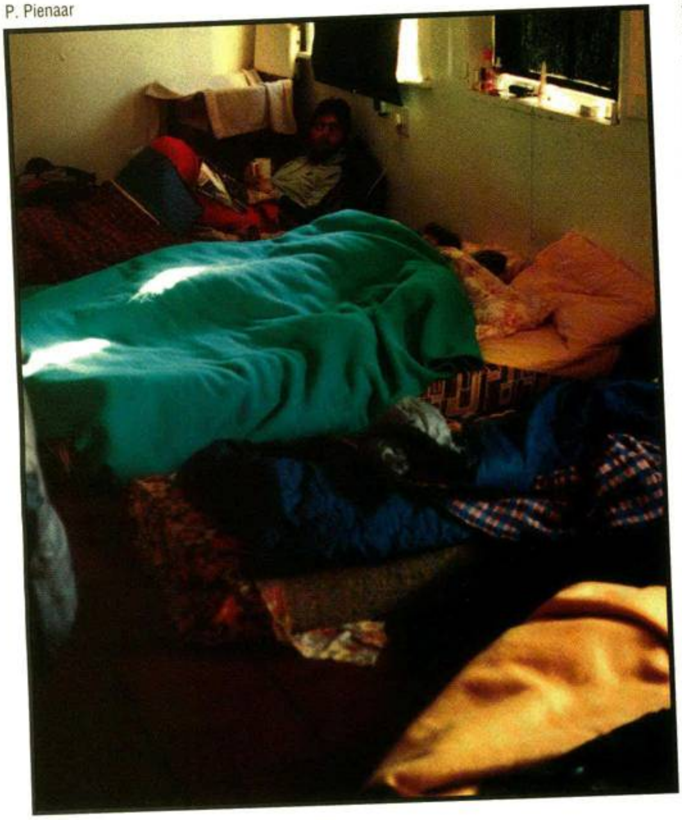
Still another black eye for Jupiter

scope. As if breaking off his holiday weren't enough, the poor man suffers a blowout and flat spare tire en route. Armed with only a minimum of test equipment, he heroically enters into a mighty battle without the benefit of circuit diagrams. Eventually the electronics, which have evidently been subject to generations of modifications, defeat him, and we are left without the ability to control the scope. Depressed, we turn to the 16-inch backup instrument. Optically, this telescope performs abysmally. Another of our cars mysteriously develops a flat. Chalking this day up as a write-off, we retire distraught.

Monday, 18 July, day three

The emotional roller coaster ride continues. Another technician arrives armed with circuit diagrams for the 60-inch's electronics; he has the scope going within an hour. We're told our microwave link to network TV is up so we can beam Jupiter pictures to the rest of the country. As night falls, a cursory glance through the instrument shows the 60-inch is truly back in action; it's back to work. With cables running all over the observatory grounds, we have to be very careful where we walk.

P. Pienaar



Sleeping in close quarters

One back-up color camera is installed on the 13-inch, but it gives a somewhat snowy image. The 60-inch gives the best images by far. Oblivious to our ups and downs, Jupiter and the comet put on the show of the century. Even an 8-inch home-brewed telescope clearly shows a gigantic black spot in Jupiter's southern hemisphere. Its size could swallow Earth whole and leave room for dessert. We hear radio reports that impact sites are visible in 6-inch instruments. People are literally jumping up and down with excitement.

Professional astronomers are reportedly pleased to have our video feed from national TV — their Sutherland observatory site is largely clouded out. That whole evening, the nation sees our Jupiter images live on the news.

Tuesday, 19 July, day four

Today we tackle the 13-inch's snowy-picture problem. We dismantle its entire set of video equipment and reroute cables carefully. We splice in a transformer wired into the mains and reconnect everything carefully. This pays dividends: The video images are now much less prone to noise. We feed the signal into the observatory's main hall so visitors can glimpse a relatively wide-field view of Jupiter, which includes two moons.

One of our club members lands fairly good still images with an ST-6 CCD camera on a 10-inch SCT. After two passes through an image processor's "sharpening" routine, detail in the impact sites is tantalizing. As the planet drops toward the horizon, the seeing worsens and the 13-inch begins to outperform the 60-inch in image quality.

Wednesday, 20 July, day five

It's time to do mundane tasks such as shopping for provisions and washing clothes. Dusk is heralded by a total onslaught from the public. Even a TV network microwave technician fields numerous phone calls — including several from callers with telescopes — asking where to find Jupiter in the sky. Having undergone a 15-second orientation course, the technician directs their attention to the brightest object near the Moon.

Other members of ASSA's Transvaal Center drive five hours after work to come and see us. They observe Jupiter for a while, give some impromptu lectures, present sky tours, and generally help with visitors.

At the time of Q impact, we see nothing new, but professional astronomers at the South African Astronomical Observatory in Sutherland report a huge infrared flash. Later, just as the planet becomes too low to observe, we glimpse the beginnings of a new dark spot. Our live Jovian images figure prominently in a special nationwide newscast. When things taper off after Jupiter sets, our Transvaal Center friends start their five-hour drive home. They have to be ready for work the next day.

Thursday, 21 July, day six

The telephone wakes us up at 7:10 a.m. for a radio interview. The flu and work commitments send some of our contingent home. The rest of us go exploring some old buildings on the Boyden Observatory site.

In the middle of this evening's observing, technicians from national TV retrieve some of the equipment their network loaned us. Our deal with the network says we have it until Saturday; evidently messages were garbled in the confusion. Our pleading compels them to leave an electronic amplifier, but we mourn the passing of their Betamax studio-quality recorders. Fortunately, we have VCRs of our own.

To add to our misery, an eyepiece holder on the 13-inch breaks, so we have to tape the camera in place. At least Jupiter clearly shows the devastation that the previous 24 hours of impacts have wrought. Two large sunspotlike dark features are prominent, exhibiting hints of fine internal detail, as well as several smaller markings.

Friday, 22 July, day seven

We finally have a lazy morning. In our wanderings we find a strange flanged tube standing in a corner of an alcove in the 60-inch dome. It turns out to be the primary baffle of that instrument. Presumably it was removed but not replaced when the mirror was aluminized.

Two more from our core group leave, having prior commitments in Cape Town. The rest of us are left to ourselves and silently watch as our video equipment captures Jovian images on tape. I fear that after the week's events the accumulated effects of sleep deprivation are finally catching up.

Once Jupiter is too low to observe, we turn the big 60-inch on Saturn, a process that occupies about half an hour. The seeing deteriorates early, then improves again unexpectedly for a while (just to lull us into a false feeling of security) before finally settling down to provide watery images until it's time to close up. Maybe the atmosphere is tired too.

Saturday, 23 July, day eight

We pack up for the trek home. While looking forward to the comforts of home, we find ourselves peculiarly reluctant to leave. I wonder what life here must have been like 50 years ago during the observatory's heyday — certainly nothing like the turmoil of today's metropolitan existence.

Packing and tidying proceed remarkably swiftly. After the usual last-minute checks against leaving anything behind followed by a round of handshakes, I'm on my way home by lunchtime.

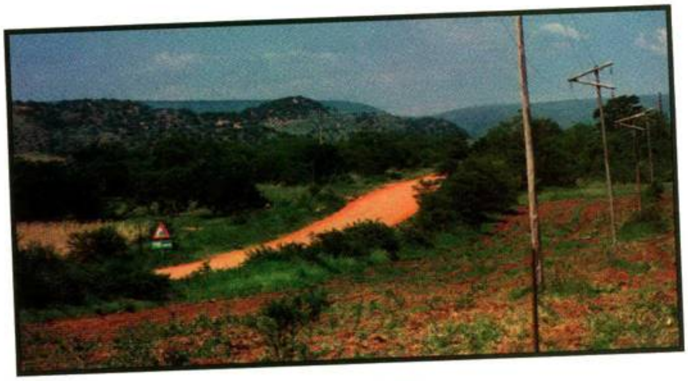
No sooner do I get back home then the weather turns uncharacteristically bad, with cloudy skies, snow in the Transvaal, and temperatures of –10° C in Bloemfontein. On balance, I'd say our luck held, more or less.

The aftermath

What's there to say about the crash when all's said and done? Well, Jupiter is still telling a story; the professionals are working full time on that one. Our club must decide exactly what to do with the many hours of videotape we successfully recorded. Before the event, we only had time to prepare; perhaps others are better qualified to utilize our video data.

Did we achieve our goals and accomplish our mission? Most definitely, yes. Besides sharing the event with the public, our group got hours and hours of data in an objective form. Now it's waiting to be duplicated and disseminated for analysis. By means of the magic of frame-grabbers and video-editing machines with digital frame stores, we can pick out the best frames taken during moments of good seeing and enhance them digitally.

As for our goal of popularizing astronomy throughout South Africa, thanks to our efforts an entire nation saw it live on TV. Next semester's UOFS astronomy courses have already shown a dramatic increase in enrollment. Our center even got a boost in membership.

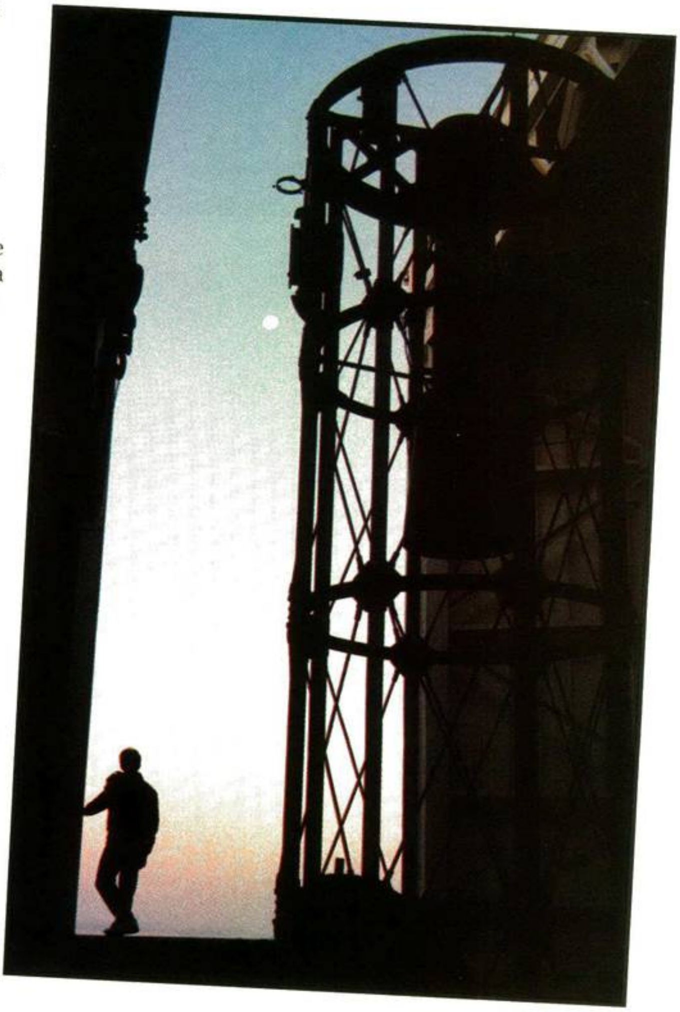


Transvaal environs

The week's activities might even lead to a revival of the Boyden Observatory; several hundred people visited Boyden to experience the event firsthand. The UOFS is making a documentary about the event and our use of the observatory, including a time-lapse section from our video that shows Jupiter's rotation and the evolution of the impact zones.

From all this experience I've learned that if people think big, then big accomplishments are possible. A group of people with diverse skills, character, and backgrounds can on short notice meld themselves into a very effective task force if they share a goal.

A year ago I would have laughed if someone had told me our club would have the gall to borrow several million dollars worth of equipment for a week to promote our hobby. Now I know that determination will not only move proverbial mountains but also capture comet crashes.



Twilight at Boyden

Chris Stewart is an avid deep-sky observer and telescope maker who lives in Roodepoort, South Africa.

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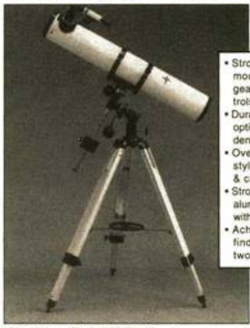

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7x50	#9306	**$129** (4.44)
10x50	#9308	**$134** (4.44)

Orion® 50mm UltraView™

The perfect binocular for eye- and sunglass wearers. Extra-long 23mm eye relief and unique rubber pop down eyepiece guard allows viewing with or without eyeglasses. Fully multi-coated optics. BAK-4 prisms. Wide 6.5° field of view. Close focus 16'. Weighs 32 oz.

10x50	#9351	**$169** (4.95)
7x50	#9357	**$179** (4.95)

7x50 Adlerblick Binoculars

Incredible wide-field eyepiece design. Fully multi-coated. BAK-4 prisms make the 7x50 Adlerblick rival European brands selling for many times the price. 7° field of view, eye relief 26mm, exit pupil 7.14mm. Soft roll-down rubber eyeguards. Weighs 28 oz.

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Orion® 8x56 Mini Giants

56mm objective lenses gather over 2.5x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects and daytime viewing. Multi-Coated BAK-4 optics. 6° field of view.

Standard Model	#9504	**$179** (4.71)
Rubber Armored Model	#9627	**$179** (5.07)

Orion® Observer™ II 12x50

Extra-high power binoculars for long distance viewing. Fully coated optics provide sharp, clear images. Wide 6° field of view. Unique adjustable hand strap, built-in rubber eyeguards. Tripod adaptable. Weighs 25 oz.

#9645 **$119** (4.44)

80mm FMC Giant Binoculars

20% more light transmission than "fully coated"-Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC Brightest, widest field available. Ideal for deep-space observation under dark skies. Hand-holdable. #9502

16x80 MC 45% higher power, excellent for astronomy and daytime observation. Tripod recommended. #9496

20x80 MC Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required. #9498 **$469** (8.05)

Orion® 70mm FMC Giants

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Hybrid 1.25"/.965"	#8782	**$29.95** (2.98)

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for C-90	#7115	**$34.95** (2.98)

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Ideal for all refractors and compound telescopes used for terrestrial viewing.

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.965" Diagonal #8791 **$44.95** (3.45)

B. 90° Star Diagonal Prisms

Orion's multi-coated diagonals are ideal for refractors and Schmidt-Cassegrains.

1.25" Star Diagonal	#8763	**$49.95** (2.98)
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For Schmidt-Cass.	#8772	**$109** (3.45)
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- For ANY telescope, with or without a motor drive. Even altazimuth or Dobsonian scopes!
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- Built-in electronic sky catalog—find subjects by their common catalog name, not their coordinates. Complete with object descriptions.
- Powered by a single 9v battery. Weighs just 6 oz!

Sky Wizard Model 1
Includes the Messier Deep Space Catalog of 110 objects, 28 bright stars, and the planets. #7801 **$199** (4.11)

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Huge 2100+ object database, plus a user catalog to store 27 objects of your choice. #7802 **$319** (4.44)

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SKY ALMANAC

Highlights
by Jeff Kanipe

Date	Event
17	Moon and Saturn in Morning Sky . . *(p. 62)*
23	Moon and the Hyades . . . . . . *(p. 59)*
All month:	
	Meteor Shower *(p. 54)*
	First Views:
	Comet d'Arrest *(p. 59)*
	Asteroids Hygiea and Thisbe . . . . *(p. 62)*
	The Dance of Saturn's Moons . . . . . . *(p. 63)*
	Observer's Challenge:
	The Moons of Uranus . . . . . . *(p. 61)*
	The Starry Sky:
	Sagittarius . . . *(p. 60)*

Skywatchers see a meteor shower and a Moon that visits Taurus' Hyades. Observers with scopes track a comet, the moons of Uranus, and two asteroids.

by Deborah Byrd

Stand under the sky as the July twilight fades, and you'll see the glories of the summer Milky Way sharpen overhead. As evening matures, the last vestiges of the twilight fade, turning the sky dark blue with a rich sprinkling of pin-point stars sparkling along the eerie band of Milky Way from Cygnus in the north to Sagittarius in the south.

This time of year lets us treasure a bright collection of stars called the Summer Triangle as we follow the Milky Way's stream of light into the broad river of stars and fuzzy glows toward the center of our Galaxy, in Sagittarius.

The summer Milky Way star patterns outclass those in other seasons in pure detail and splendor. A naked-eye view of the star clouds in Cygnus, Aquila, or Scutum shows remarkable detail, like dark clouds of dust set against the glowing light from tens of thousands of more distant stars. Binoculars or a small telescope resolve some of the fuzzy knots of stars into clusters of young suns born from interstellar gas.

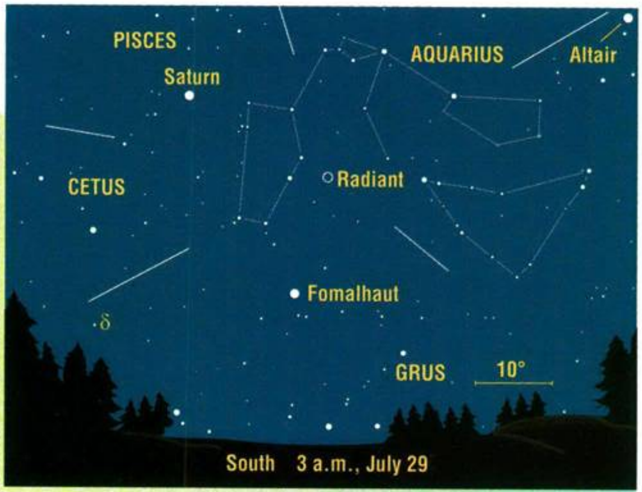
Even as we see these celestial nurseries at work, the seemingly less-active dark clouds are waiting in the queue: In millions of years they will collapse into regions of active starbirth.

When we look at this band of stars today, we know we are looking edgewise into the plane of our Galaxy. As we view Sagittarius, we are looking toward the galactic center, which lies obscured by dust light-years beyond the veil of star clouds we see in this part of the sky. What we do see in Sagittarius consists of stars, gas, and dust in the spiral arm of the Galaxy next-inward from our own, the Sagittarius arm.

These dark and bright patches along the summer Milky Way fascinated early stargazers, who devised countless legends about them. Some early skywatchers believed the Milky Way represented milk from the breast of a goddess, while others thought it a bridge to heaven traveled by warriors after their deaths. I like to think their explanations were as real to them as our modern-day knowledge of the Milky Way is to us. I wonder what people will think of the Milky Way a thousand years

(continued on page 59)

A July Meteor Shower



Observers out past midnight, particularly those in the mid-northern to southern reaches of the world, may notice a few more "shooting stars," especially toward the end of the month.

The Southern Delta Aquarid meteor shower, which peaks on July 29, is one of the longest duration showers, lasting from July 8 to August 19.

The radiant for this stream is highest around 3 a.m., and is located at –16° declination near the 3rd-magnitude star Delta Aquarii, called Skat. This year, the Moon stays out of sight all night, having come to new phase on the 27th.

With an hourly rate of 20 meteors, the Southern Delta Aquarids are more of a "spritz" than a shower. Still, numbers aren't everything. They do tend to be fairly bright and move at a leisurely 41 kilometers (25 miles) per second, the brightest ones (roughly 5 percent) leaving brief smoke trains.

The dust from these trains lingers in the Earth's upper atmosphere, between 75 and 90 km above the ground, for some time before completely dissipating. It's meteor dust that might create the elusive noctilucent clouds.

Observers living north of latitude 45° glimpse these clouds low in the north about an hour after sunset. Fringed along the edge that's closest to the northern horizon, for the most part the clouds take on a silvery bluish-white as they reflect sunlight from their lofty location. — *Jeff Kanipe*

1995

JULY

3 Earth is at aphelion (94.5 million miles from the Sun), 10 p.m. EDT

4 Moon passes 4° south of Mars, 1 a.m. EDT

5 First Quarter Moon is at 4:02 p.m. EDT

9 The Moon passes 2° north of Jupiter, 9 a.m. EDT

11 The Moon is at perigee (215,264 miles from Earth), 6:00 a.m. EDT

12 Full Moon is at 6:49 a.m. EDT

17 The Moon passes 6° north of Saturn, midnight EDT (p. 62)
Neptune is at opposition, 1 a.m. EDT

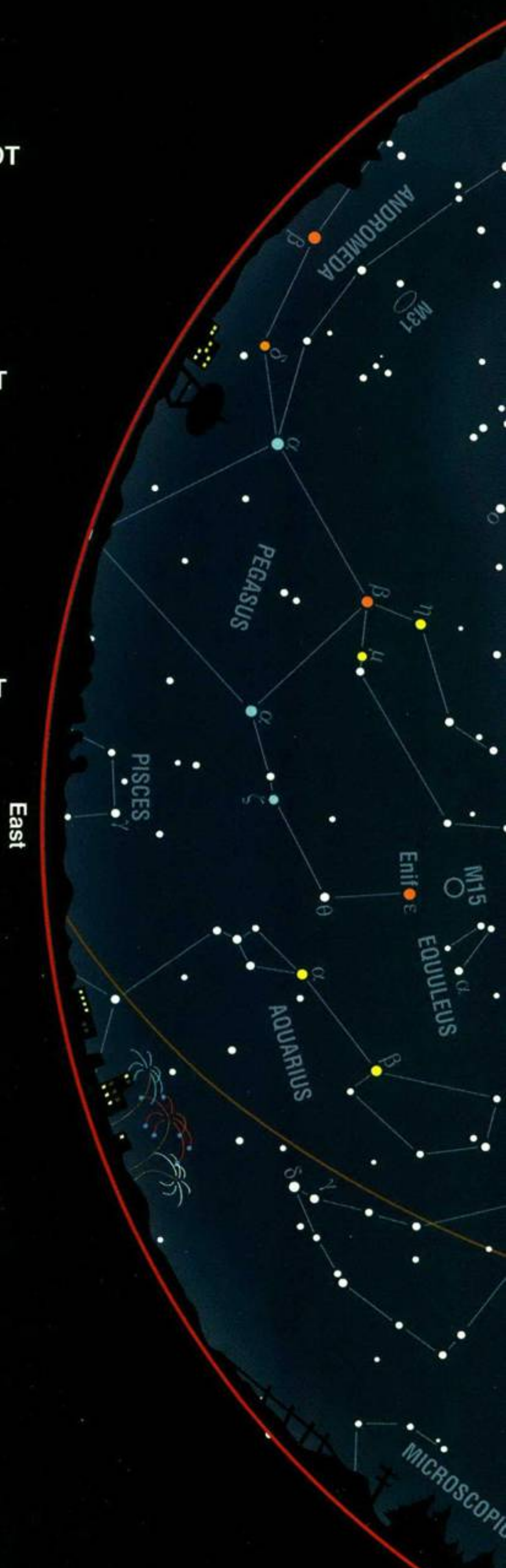
19 Last Quarter Moon is at 7:10 a.m. EDT

21 Uranus is at opposition, 2 p.m. EDT

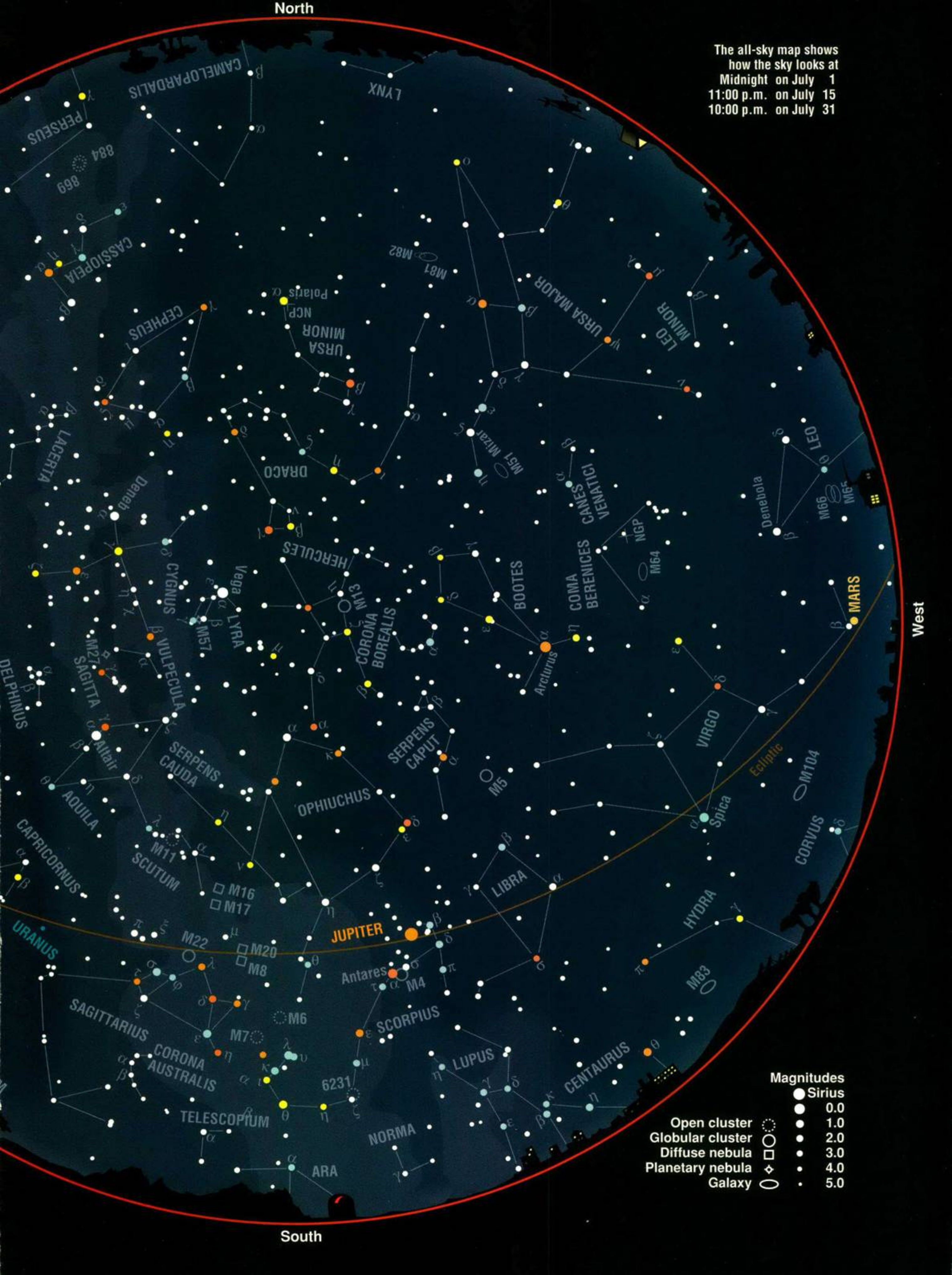
23 The Moon is at apogee (243,430 miles from Earth), 4:16 p.m. EDT

27 New Moon is at 11:13 a.m. EDT

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
30 🌒	31 🌒					1 🌒
2 🌒	3 🌒	4 🌒	5 🌓	6 🌔	7 🌔	8 🌔
9 🌕	10 🌕	11 🌕	12 🌕	13 🌕	14 🌕	15 🌕
16 🌖	17 🌖	18 🌖	19 🌗	20 🌘	21 🌘	22 🌘
23 🌘	24 🌘	25 🌘	26 🌘	27 🌑	28 🌑	29 🌒



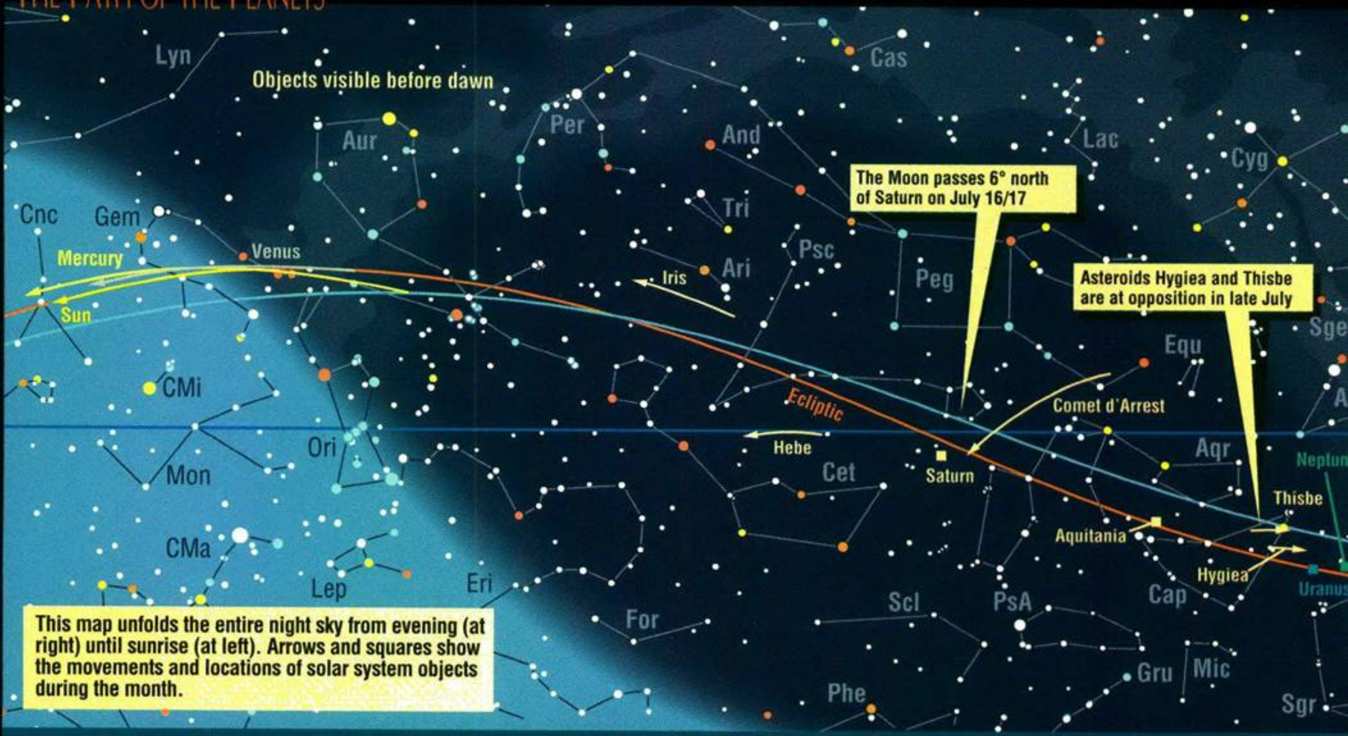
This map portrays the sky at times shown in the upper right corner of the page. Located just outside the map are the four directions: *north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a directio* label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.



The all-sky map shows
how the sky looks at
Midnight on July 1
11:00 p.m. on July 15
10:00 p.m. on July 31

North
South
West
CAMELOPARDALIS
LYNX
PERSEUS
884
869
CASSIOPEIA
Polaris
NCP
URSA MINOR
M82
M81
URSA MAJOR
LEO MINOR
CEPHEUS
LACERTA
DRACO
Mizar
M51
LEO
M66
M65
Denebola
Deneb
CANES VENATICI
NGP
M64
HERCULES
M13
CYGNUS
Vega
LYRA
M57
BOOTES
COMA BERENICES
CORONA BOREALIS
Arcturus
MARS
VULPECULA
M27
SAGITTA
DELPHINUS
VIRGO
Altair
SERPENS CAUDA
SERPENS CAPUT
M5
Ecliptic
M104
AQUILA
OPHIUCHUS
Spica
CORVUS
CAPRICORNUS
M11
SCUTUM
M16
M17
LIBRA
HYDRA
URANUS
M22
M20
M8
JUPITER
Antares
M4
M83
SAGITTARIUS
M6
SCORPIUS
M7
CORONA AUSTRALIS
LUPUS
CENTAURUS
6231
TELESCOPIUM
NORMA
ARA
Magnitudes
Sirius
0.0
1.0
2.0
3.0
4.0
5.0
Open cluster
Globular cluster
Diffuse nebula
Planetary nebula
Galaxy

THE PATH OF THE PLANETS

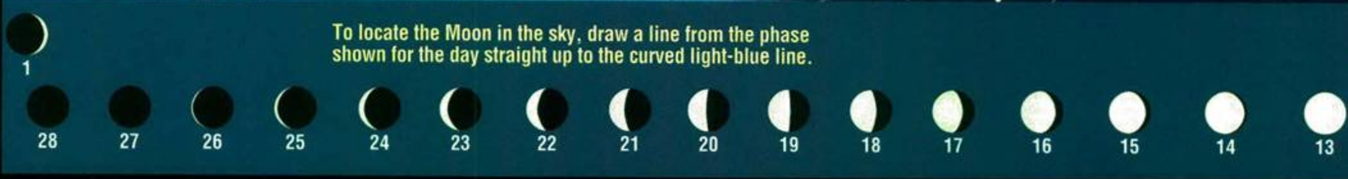

Lyn
Cas
Aur
Per
And
Lac
Cyg
Cnc
Gem
Tri
Mercury
Venus
Psc
Peg
Iris
Ari
Sun
Sge
Equ
CMi
Ecliptic
Comet d'Arrest
Ori
Hebe
Aqr
Neptun
Mon
Cet
Saturn
Thisbe
CMa
Aquitania
Hygiea
Lep
Eri
Cap
Uranu
For
Scl
PsA
Gru
Mic
Phe
Sgr

Objects visible before dawn

The Moon passes 6° north of Saturn on July 16/17

Asteroids Hygiea and Thisbe are at opposition in late July

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objects during the month.


1
28
27
26
25
24
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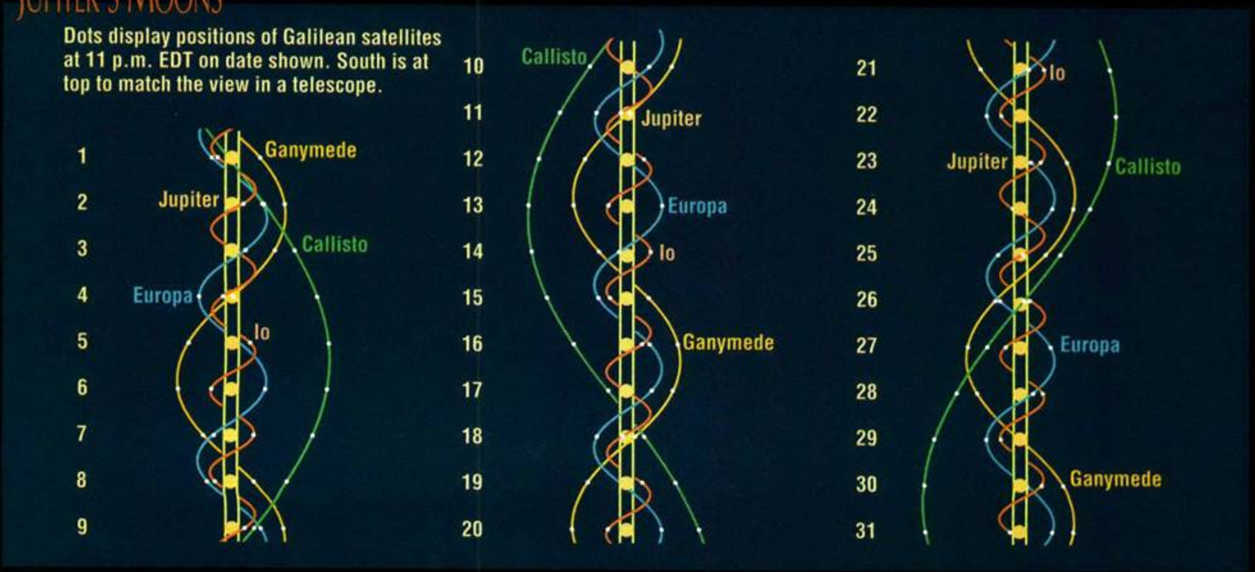
15
14
13

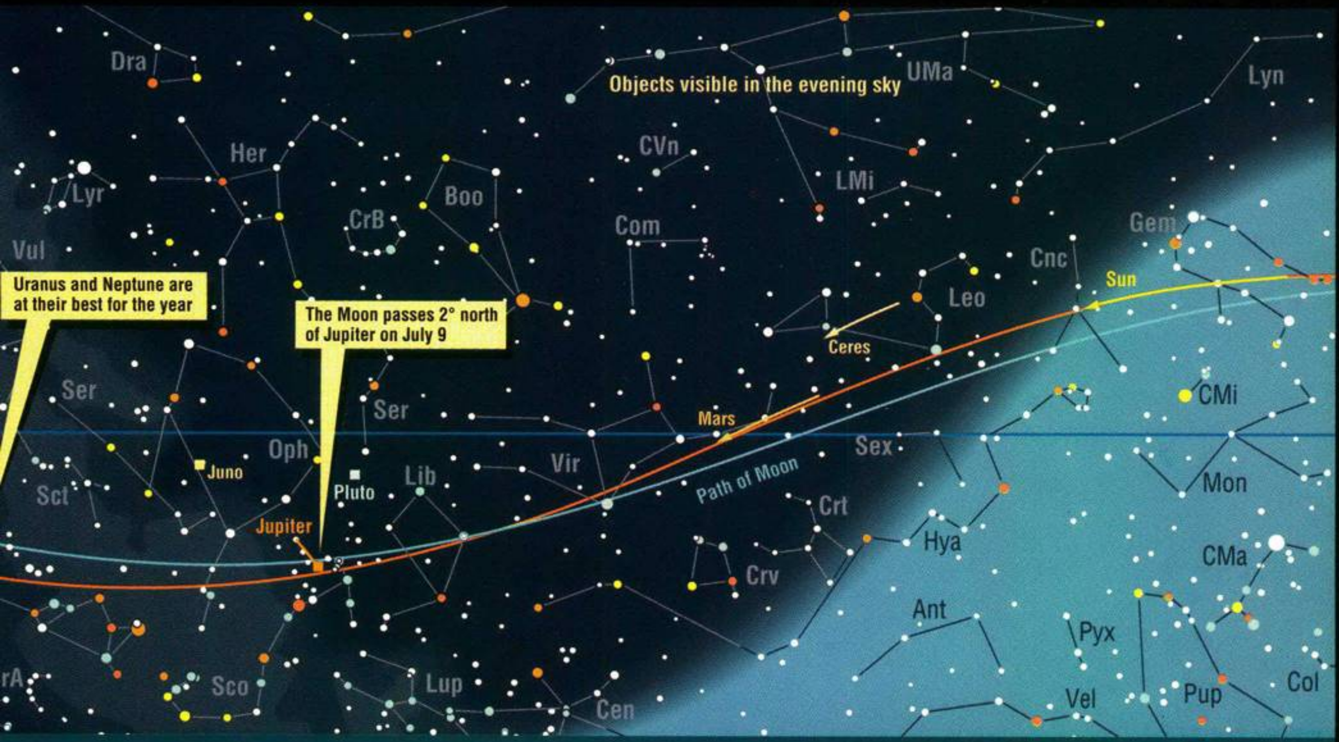
To locate the Moon in the sky, draw a line from the phase shown for the day straight up to the curved light-blue line.

PLANETS	MERCURY	MERCURY	VENUS	MARS	JUPITER
Date	July 1	July 15	July 1	July 15	July 15
Magnitude	0.4	–1.0	–3.9	1.3	–2.4
Angular Size	7.8"	5.7"	10.0"	5.4"	43.1"
Illumination	40%	80%	97%	91%	100%
Distance (AU) from Earth	0.864	1.173	1.665	1.749	4.569
Distance (AU) from Sun	0.388	0.316	0.721	1.595	5.326
Right Ascension (2000.0)	5h04.9m	6h33.3m	5h37.6m	11h47.4m	16h17.5m
Declination (2000.0)	19°48'	23°05'	23°02'	1°57'	–20°40'

JUPITER'S MOONS



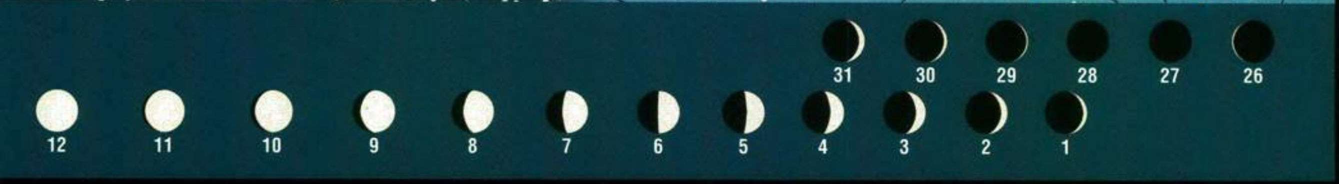
Dots display positions of Galilean satellites at 11 p.m. EDT on date shown. South is at top to match the view in a telescope.


Dra
UMa
Lyn
Lyr
Her
CVn
LMi
Boo
CrB
Com
Vul
Gem
Cnc
Sun
Leo
Ceres
Ser
Ser
CMi
Mars
Sex
Oph
Juno
Vir
Path of Moon
Scl
Pluto
Lib
Crt
Jupiter
Hya
CMa
Mon
Crv
Ant
Pyx
rA
Sco
Lup
Cen
Vel
Pup
Col

Objects visible in the evening sky

Uranus and Neptune are at their best for the year

The Moon passes 2° north of Jupiter on July 9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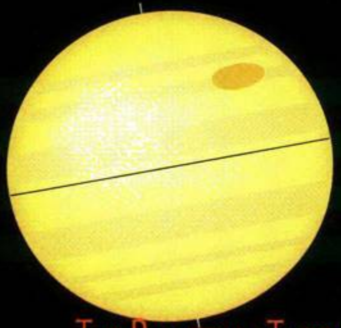
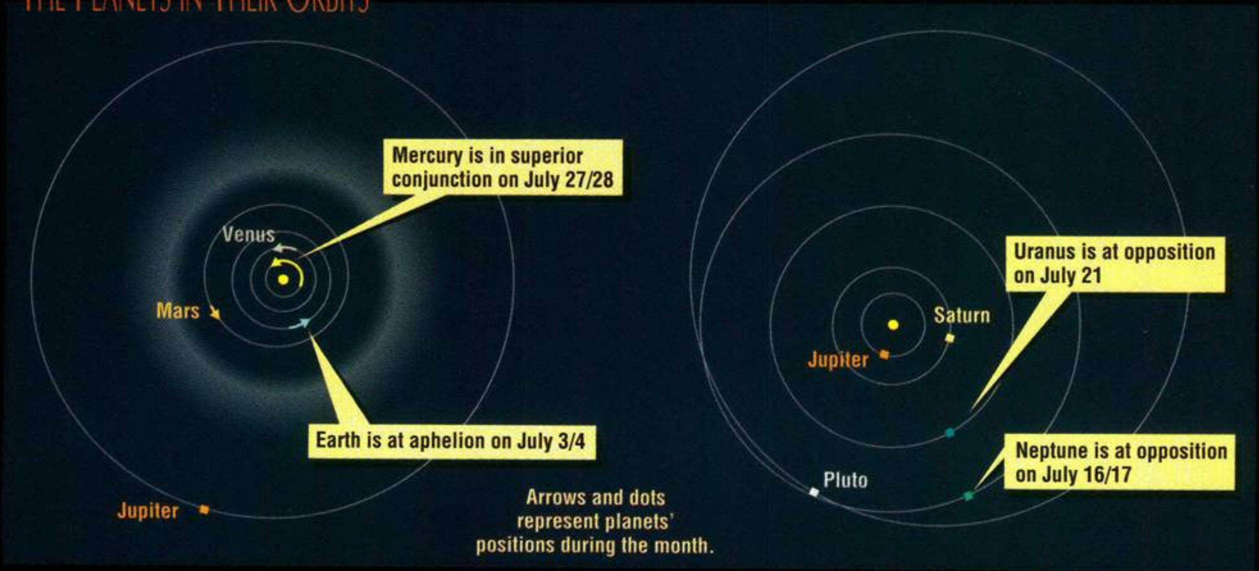


SATURN	URANUS	NEPTUNE	PLUTO
July 15	July 15	July 15	July 15
1.0	5.6	7.9	13.7
18.2"	3.8"	2.3"	0.1"
100%	100%	100%	100%
9.117	18.711	29.154	29.255
9.627	19.721	30.169	29.846
23h44.2m	20h04.3m	19h44.3m	15h55.3m
–4°05'	–20°57'	–20°43'	–6°22'

THE PLANETS IN THEIR ORBITS


Venus
Mars
Jupiter
Saturn
Jupiter
Pluto

Mercury is in superior conjunction on July 27/28

Earth is at aphelion on July 3/4

Uranus is at opposition on July 21

Neptune is at opposition on July 16/17

Arrows and dots represent planets' positions during the month.

from now when they stand outside on summer evenings, gazing up at its arc of glowing light.

Though the riches of the Galaxy's stars shine brightly this time of year, we are also able to observe a bounty of planets this month. Most prominent in the western evening sky is ruddy **Mars**, which spends the month on a slow dance through the constellations Leo and Virgo.

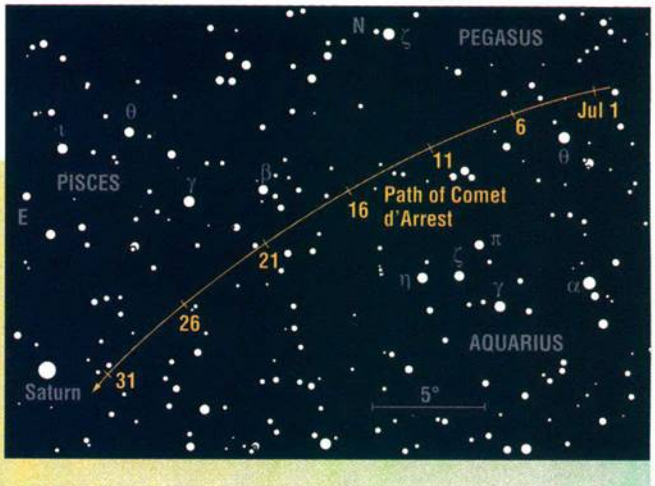
Mars shines boldly in the southwest, lying not far from the bright star Denebola as the month begins. At that time it glows at magnitude 1.3 and spans only 5 arcseconds as seen in a telescope. On the evening of July 3 the Moon will pass within 4° of Mars on its monthly journey around our sky.

Shift your gaze to the southeastern sky and you'll be struck by the brightness of mighty **Jupiter**, which shines at magnitude –2.4. Now mostly recovered fully a year after being struck by Comet Shoemaker-Levy 9, Jupiter lies in the constellation Scorpius near a trio of stars in a little arc northwest of Antares, the constellation's bright, orangy star. The little stars forming the arc are sometimes collectively called the Crown of the Scorpion.

A small telescope reveals the planet's alternating cloud bands and easily shows its four brightest moons, and when the right side of the planet faces us, it exposes the planet's Great Red Spot, an enormous storm. On July 8 look for Jupiter as it hangs near the gibbous Moon in the evening sky.

As the evening progresses, brilliant Jupiter gives way to the faintest of all planets, **Pluto**. Some 15° northwest of Jupiter, in the lonely constellation Libra, lies this remote, icy world. Glowing feebly at magnitude 13.7, it requires at least an 8-inch telescope to be seen, and then it appears merely as a faint star. But there's a certain fascination to be had from tracking down the ninth planet of the solar system. (See the Sky Almanac, May 1995, for a detailed Pluto map.)

First Views:
Arresting d'Arrest



Comet d'Arrest graces the late evening summer sky in Pegasus and Aquarius throughout the month. Whereas the comet hovered around magnitude 11 last month, it brightens more than a magnitude in July, brightening to magnitude 7.8 by the end of the month.

Our icy interloper rises with the head of Pegasus around 10:30 p.m. on the first of July. Early in the month, look a couple of degrees northwest of Theta (θ) Pegasi, the horse's "eye," for a misty patch of gray light. The object should be fairly obvious in binoculars or a low-power field of view.

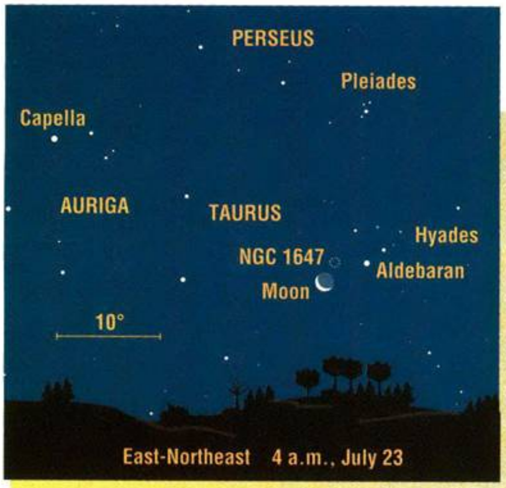
As July progresses, d'Arrest moves southeast against the apparent east-west movement of the stars, diving down almost perpendicularly to the horizon into the eastern realm of Aquarius. Its apparent movement against the stars is in the general direction of Saturn. The comet should brighten considerably by midmonth to about magnitude 9. The coma will appear slightly elongated and, in medium to large telescopes, may sport a stubby tail.

Note: On the 31st, d'Arrest lies only 1.4° west of Saturn. Both objects should fit in a wide field of view, providing an interesting photo opportunity with a telescope or long focal-length lens. — *J.K.*

Coordinates for Comet d'Arrest (4 a.m. EDT)

Date	R.A. (2000)	Dec.	Mag.
July 1	22h04.9m	8°20'	10.4
July 6	22h19.3m	7°12'	10.1
July 11	22h33.9m	5°40'	9.8
July 16	22h48.7m	3°44'	9.3
July 21	23h03.4m	1°23'	8.7
July 26	23h17.8m	–1°23'	8.2
July 31	23h31.7m	–4°30'	7.8

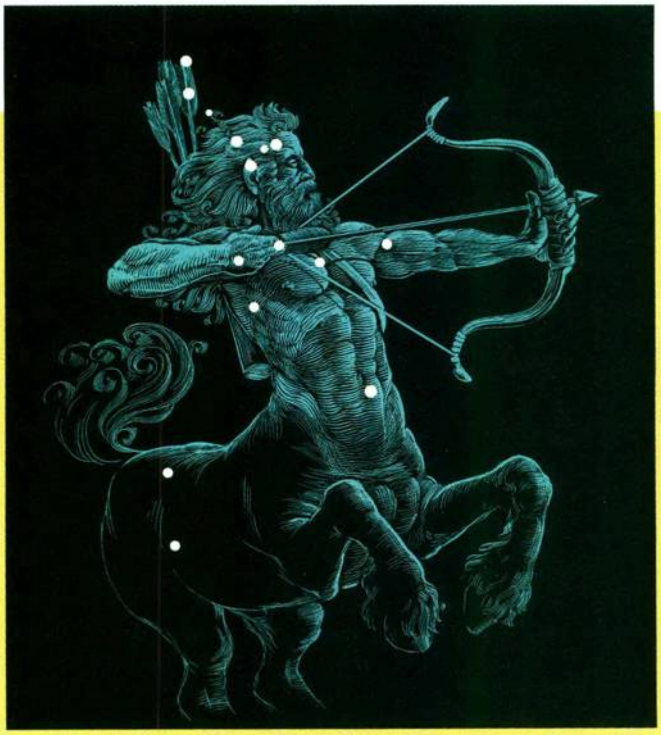
The Moon in the Hyades



On the 23rd, around 4 a.m. local time, watch as a slim crescent Moon edges up through the trees near the horns of Taurus, the Bull. Higher up in the eastern morning sky is the nexus of stars forming the Pleiades Cluster. It rises first, and then bright Aldebaran; to the lower left is the crescent Moon, its dark side blushed faintly with Earthshine.

An introspective sight, to be sure. Also a good photo opportunity. To fit in the Moon and Hyades in one frame, use a 100mm lens at f/4. Select ISO 64-speed slide film, and bracket around an exposure of about half a second, depending on the sky brightness (a little shorter if twilight is strong; longer if twilight is slight). The longer you expose the more Earthshine you'll record, but you'll also pick up more glare from the bright limb of the Moon. Trailing stars are not a problem for a 100mm lens in only a few seconds. If you decide to zoom in with a longer focal-length lens, however, the stars may appear slightly trailed in exposures greater than a few seconds. — *J.K.*

The Starry Sky:
Sagittarius



Uranus and Neptune come to opposition this month in front of the constellation Sagittarius, the Archer, with its famous Teapot asterism. The Teapot is a noticeable pattern in the south on July evenings. Third-magnitude Kaus Borealis marks the top of the Teapot's lid, and another 3rd-magnitude star, Gamma Sagittarii, marks the tip of the spout. Second-magnitude Nunki marks the top of the Teapot's handle.

If you look in a dark sky on a moonless night toward the Teapot, you will find that the starlit trail of the summer Milky Way gets wider and richer as it cascades toward Sagittarius. This whole region of the heavens is ablaze with the combined light of millions of stars. Not surprisingly, Sagittarius points toward the center of our Milky Way Galaxy. The galactic center lies 5° west of the Teapot's spout.

From the middle latitudes, the Milky Way looks like clouds of steam rising from the Teapot's spout. The Teapot's handle and half of its lid make another asterism, sometimes called the Milk Dipper. This asterism is more perfect in shape than the famous Little Dipper of the northern sky. The Milk Dipper appears to scoop up stars in the Milky Way. It is a sight sure to nourish your soul on these warm summer nights.

Besides being home to these striking asterisms, Sagittarius is also known for its star clouds and clusters and nebulae in all shapes and sizes. Many are visible to the naked eye. Lie back with your binoculars on a clear, dark night and spend hours examining this region of the heavens. Telescope users return again and again throughout their lives to the riches found here. Be sure to look for the Lagoon Nebula and the Small Sagittarius Star Cloud. They've been described as looking like "puffs of steam floating back in a gentle line from the Teapot's spout." Beyond them is the Large Sagittarius Cloud.

In ancient mythology, Sagittarius represented an archer, often portrayed as a centaur with the body of a horse and the chest, arms, and head of a man. The archer is sometimes said to be Chiron, a name also used for the nearby constellation of Centaurus. Chiron has also been called Crotus, son of the trickster Pan, who had the legs of a goat, and Eupheme, nurse of the nine Muses.

Over the ages, Sagittarius has been many names, including the Arrow, the Rider on Horseback, the Horn-footed, and the Half-Man. The Babylonians, Turks, Persians, and Jews all referred to this constellation with names meaning "the Bow." Where Sagittarius was seen as an archer, it is interesting to ask where his bow was aimed. The answer may be toward Antares, heart of the scorpion in the neighboring constellation Scorpius.

In his book *Beyond the Blue Horizon*, E. C. Krupp suggests that the original idea for Sagittarius may have come from ancient Mesopotamia. He points out that the starry pathway of the Milky Way was seen by many ancient cultures as the road taken by souls after their deaths. Thus in some traditions, Sagittarius may represent a guardian of the door to the dead. — *Deborah Byrd*

Farther east but also visible shortly after sunset this month is the pair of distant gas giants **Uranus** and **Neptune**. Neptune reaches opposition on July 17 and Uranus does four days later (opposition is the point opposite the Sun in the sky). At this position, the planets are well-placed for observing in the late evening and will remain visible all night long. Uranus is now at *its brightest* for the year, glowing at magnitude 5.6, which makes it visible to the naked eye as a faint "star" on a dark night.

Try locating Uranus with binoculars: Once you can see exactly which dot of light it is, you may then be able to spot it with your eyes alone. This month Uranus does not lie near any particularly bright stars, but its greenish color and steady light will help distinguish it. A telescope reveals the tiny disk of Uranus, which spans 3.7" this month.

Neptune glows faintly relative to Uranus, at magnitude 7.9. Invisible to the naked eye, it is nevertheless bright enough to be seen in binoculars and small telescopes. A 3-inch scope shows the planet's 2.3"-diameter disk. Neptune is about the same size as Uranus — four Earths could be placed side-by-side inside either world — but it is far more distant than Uranus so it appears smaller.

It's a twist of fate that Uranus and Neptune appear so close to each other in our sky just when astronomers are fully appreciating the differences between the two planets. Until the Voyager flybys of 1986 and 1989 planetary scientists believed Uranus and Neptune were virtual twins. Now we know they are very different, particularly in their atmospheres.

Yet the planets remain linked in the minds of stargazers, in large part because they travel together as we see them in the sky. Their distance in the sky is slowly increasing. In the year 2000 the two planets will be separated by 15°, and a quarter-century from now they will be split by a gap of 50°.

As you ponder Neptune and Uranus, Earth continues to rotate below your feet, carrying fresh vistas of stars and planets above the eastern horizon.

Saturn rises before midnight and appears in the southern sky before dawn, floating in the constellation Aquarius. As the days of the

Observer's Challenge:
Try for the Moons of Uranus

Most backyard observers feel that you cannot see Uranus' moons in a typical backyard telescope. To spot objects so far and faint, says conventional wisdom, it takes a scope with mega-aperture. Truth is these frosty denizens of the outer solar system are visible in ordinary backyard scopes, although visual acuity might help.

So here's the challenge: Can you see any of Uranus' bright moons in a telescope? The brightest moons, in increasing order of magnitude, are Titania (13.7), Oberon (13.9), Ariel (14.2), and Umbriel (14.8). To see these four moons you need at least an 8-inch and, really, a 10-inch would be better. Bear in mind that all of these bodies are smaller than our Moon (the largest, Titania, has a diameter of 1,580 kilometers, or about 1,000 miles), so they are not exactly prominent, especially considering they are over a billion and a half miles from Earth.

Still, Uranus comes to opposition on the 21st, a time when the planet is most favorably placed for observing from Earth. Uranus' apparent disk diameter at opposition this year is a whopping 3.7", shining at magnitude 5.6. So now's your best chance to see if you can personally discover one of Uranus' minuscule moons hiding like a tiny diamond chip in the glare of the planet.

First things first, though; to find Uranus turn to page 74. There the article "Target: Uranus and Neptune" includes a detailed finder map.

Then use the diagram and elongation tables below to locate Uranus' four visible moons. First convert the time when you'll be observing into Universal Time (UT). (To convert daylight time into UT, add 4 hours to EDT, 5 hours to CDT, 6 hours to MDT, and 7 hours to PDT.) Now figure out how much each Uranian moon has moved in its orbit since the greatest northern elongation closest to your observing time. Do this by subtracting the elongation time from your observing time to get an elapsed time. Moving from 0 days on the diagram, locate this elapsed time and mark the position. That's where the moon will be on your observing date. Repeat this process for each moon to create a complete satellite position map.

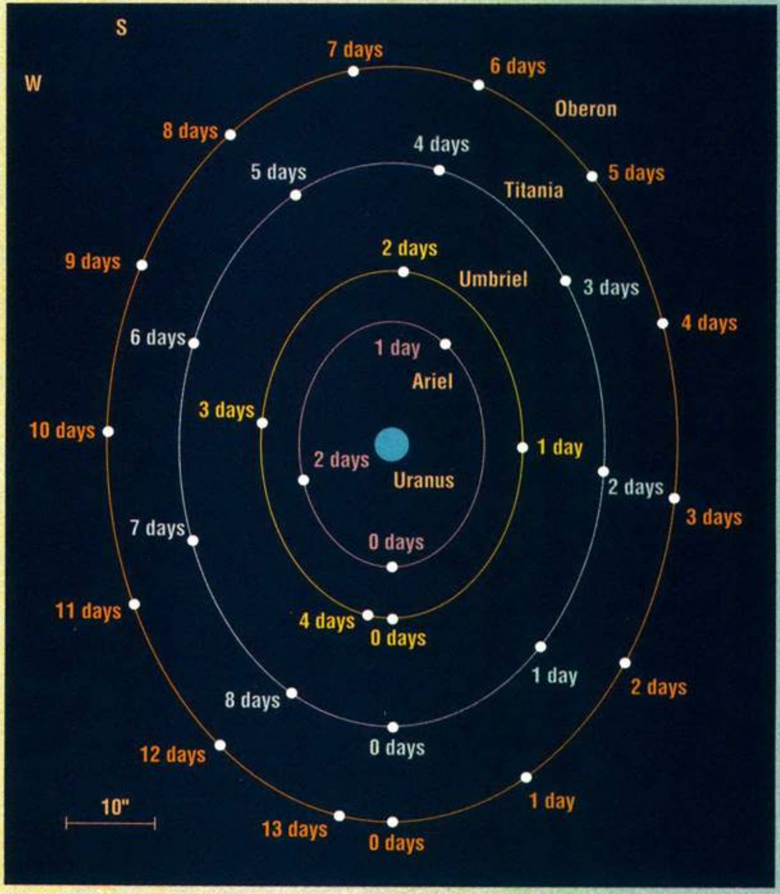
Note the scale on the diagram: Even when their orbits carry them farthest from Uranus, Titania and Oberon, the largest, outermost moons, never appear more than 33" and 44", respectively, from the planet.

If you observe Uranus' moons, please let ASTRONOMY know about it. Tell us what size and focal-length instrument you used, magnification, and sky conditions. Some patient, keen-eyed observers even track moons around Neptune, but that's grist for a future project box. — *J.K.*

Times of Greatest Northern Elongations

	Date	Time*
Ariel	July 2	15.1
	July 5	3.6
	July 7	16.1
	July 10	4.6
	July 12	17.1
	July 15	5.6
	July 17	18.1
	July 20	6.6
	July 22	19.1
	July 25	7.5
	July 27	2.0
	July 30	8.6
Umbriel	July 3	19.6
	July 7	23.1
	July 12	2.6
	July 16	6.1
	July 20	9.5
	July 24	13.0
	July 28	16.5
Titania	July 5	15.0
	July 14	8.0
	July 23	1.0
	July 31	18.0
Oberon	July 8	6.6
	July 21	18.0

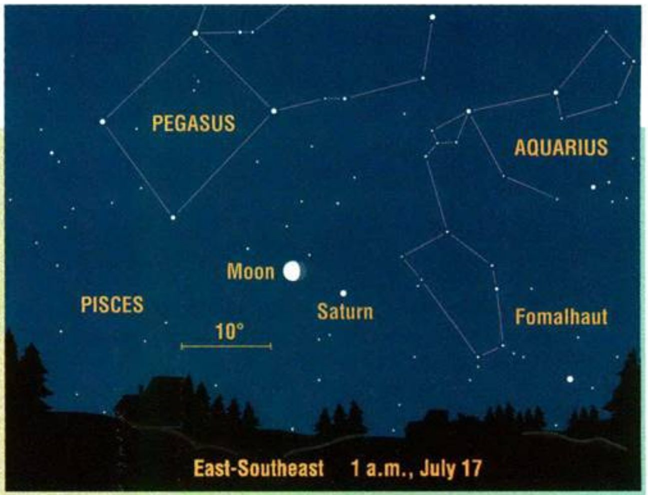
*Times given in Universal Time; subtract 4 hours to get EDT.



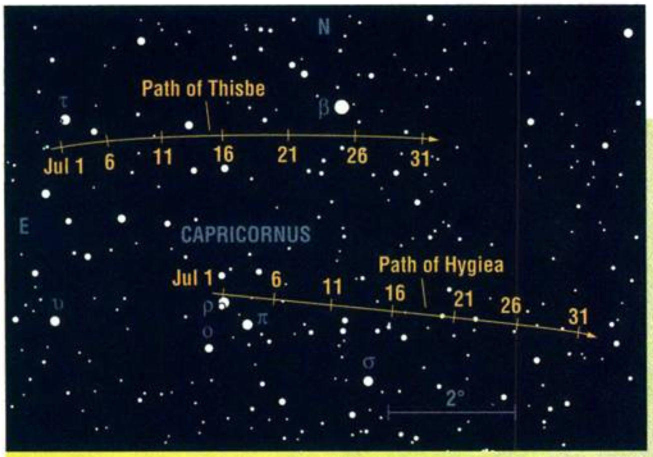
The Moon and Saturn in The Morning Sky

If you're out chasing meteors or other celestial objects in the early morning hours of July 17, you'll probably notice a bright "star" a mere 7° southeast of the waning gibbous Moon. Turn your telescope on that star and you will see Saturn, its rings edge-on like a blade halving a white grape. Saturn is presently snorkeling its way through the watery constellation Aquarius and will continue to do so for the rest of the year. If you don't see the Moon-planet pairing this month, however, don't worry. The Moon and Saturn will make no less than six more passes, one per month — and two in November — with angular separations (apparent distances) no greater than 6°.

There are a number of neat events involving Saturn's satellites this month (in fact, this year). For more on these events, see the box on the opposite page. — *J.K.*



Asteroids of the Month: Hygiea and Thisbe



Moving almost in formation across the late summer evening sky through Capricornus are two minor planets of some interest: 10 Hygiea, 450 kilometers in diameter (267 miles) and 88 Thisbe, 210 km in diameter (130 miles). Throughout July the two bodies are never more than about 5° apart in the sky and, in fact, during the last ten days of the month that gap closes to a minimum of about 4°.

Hygiea, Greek goddess of health, is the fourth-largest minor planet in the solar system. It crosses east to west through Capricornus' "smile in the sky" formed by the stars Alpha, Beta, Omicron, Iota, Gamma, and Delta Capricorni. Hygiea will be about magnitude 9.3, still quite bright in the eyepiece.

To the northeast and skirting just above the "smile" is Thisbe, moving a little faster than Hygiea, so that it begins catching up with that asteroid by month's end. According to Lutz Schmadel's *Dictionary of Minor Planet Names* (Springer-Verlag, 1994), Thisbe is one of two Babylonian lovers prominent in Shakespeare's *A Midsummer Night's Dream.*

When hunting for asteroids, it is best to use a wide-field eyepiece, especially considering the proximity of these two objects to each other. Use the accompanying diagram to help you pinpoint the search region. On the first night, thoroughly and accurately sketch the star field, noting the true cardinal directions on the edge of your plot.

Come back a night or two later and redraw the field. Compare your two sketches, looking for stars that have moved significantly out of place with respect to the other fixed stars. The two shifting "stars" are Hygiea and Thisbe. — *J.K.*

Coordinates for Asteroid 10 Hygiea (11 p.m. EDT)

Date	R.A. (2000)	Dec.	Mag.
July 2	20h28.9m	-17°44'	9.8
July 7	20h25.5m	-17°48'	9.7
July 12	20h21.8m	-17°54'	9.6
July 17	20h17.8m	-18°01'	9.5
July 22	20h13.7m	-18°07'	9.3
July 27	20h09.5m	-18°15'	9.4
August 1	20h05.4m	-18°22'	9.5

Coordinates for 88 Thisbe (11 p.m. EDT)

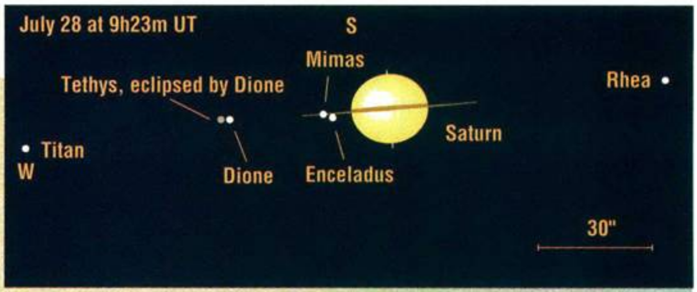
Date	R.A. (2000)	Dec.	Mag.
July 2	20h39.5m	-15°23'	10.3
July 7	20h36.5m	-15°18'	10.2
July 12	20h32.9m	-15°15'	10.1
July 17	20h28.9m	-15°13'	9.9
July 22	20h24.6m	-15°13'	9.8
July 27	20h20.1m	-15°14'	9.7
August 1	20h15.7m	-15°17'	9.8

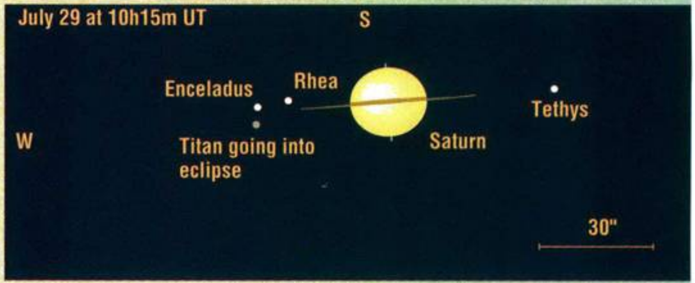
Dance of Saturn's Moons

If you've been observing Saturn during the past few years, you no doubt have noticed that its rings have been getting closer to edge-on. About every 15 years, the plane of the rings tilt edge-on to our line of sight and the rings disappear from view (see "The Vanishing Rings of Saturn," June 1995).

But other subtle effects happen as Earth passes through the ring-plane. Because most of Saturn's satellites orbit in nearly the same plane as the rings, these orbits are now also tilted nearly edge-on to our line of sight. When this happens, the satellites sometimes pass into the shadow of the planet. Or they may pass in front of (occult) or eclipse one another; these are called mutual events.

The table lists the best mutual events, most of which are only visible from certain spots on Earth. For North Americans, the best-timed mutual event occurs on July 28, when Dione eclipses Tethys (see top right diagram). The best eclipse by Saturn happens July 28, when Saturn projects its shadow on Titan. —*J.K.*





Mutual Events of Saturn's Satellites

Date	Begin Time	End Time	Event	Type of Event	Light Loss	Distance
July 1	2h31.4m	33h32.7m	Enceladus occults Mimas	Partial	11%	2.8
July 13	5h30.7m	5h26.0m	Mimas eclipses Enceladus	Partial	18%	3.0
July 14	1h42.4m	1h44.7m	Dione occults Tethys	Partial	38%	3.8
July 16	1h02.2m	1h14.5m	Tethys eclipses Dione	Annular	80%	4.3
July 18	17h14.2m	17h15.9m	Tethys occults Enceladus	Total	20%	2.9
July 19	19h04.5m	19h07.2m	Rhea occults Tethys	Partial	9%	4.3
July 22	0h01.7m	0h07.7m	Tethys eclipses Enceladus	Total	100%	3.9
July 22	1h57.7m	1h59.7m	Tethys eclipses Mimas	Partial	14%	2.9
July 23	23h15.2m	23h17.2m	Tethys eclipses Mimas	Partial	31%	2.9
July 25	20h32.9m	20h34.9m	Tethys eclipses Mimas	Partial	44%	2.9
July 27	17h50.7m	17h52.7m	Tethys eclipses Mimas	Partial	51%	3.0
July 28	9h20.0m	9h26.4m	Dione eclipses Tethys	Partial	26%	4.9
July 29	1h04.5m	1h05.9m	Enceladus occults Tethys	Annular	18%	2.2
July 29	15h08.4m	15h10.7m	Tethys eclipses Mimas	Partial	58%	3.0
July 31	12h26.2m	12h28.5m	Tethys eclipses Mimas	Partial	64%	3.0

Begin Time: Universal time at start of event. (Subtract 4 hours to convert to EDT.) **End Time:** Universal time at end of event. **Type of Event:** The nature of the event and the moons involved. **Light Loss:** For eclipses — the percent of light lost by the eclipsed satellite at midevent; For occultations — the percent of light lost from the combined light of both satellites at midevent. **Distance:** The distance of the satellite from Saturn's center expressed in units of Saturn's equatorial radius.

month roll by, its bright, creamy-yellow light stops moving eastward against the background stars and begins slow retrograde, or westward, motion. This occurs on July 7, as the planet shines at magnitude 1.0. On the mornings of July 16 and 17 you'll find the Moon close by Saturn, making an approach of 8°.

This year's opposition of Saturn, which occurs in September, will be widely viewed because of a special circumstance. This year Earth passes through the ring-plane of Saturn, causing the Ringed Planet's rings to disappear. Three periods spread over a year offer a view of Saturn's globe without rings. For details on this series of events, see "The Vanishing Rings of Saturn," June 1995.

Bringing up the rear in July's parade of planets are **Mercury** and **Venus**, which because they are inner planets never appear to stray far from the Sun. Mercury reached greatest western elongation in late June. During the first days of this month Mercury is visible with difficulty low in the brightening eastern sky, about 45 minutes before dawn. The horns of the bull in Taurus appear to point straight down toward it. The planet shines at magnitude 0.2 as July begins and it brightens slowly over the month, but sinks closer to the Sun's glare.

Venus is so bright, at magnitude –3.9, that you may spot it with ease even though it lies 10° lower in the east than Mercury. Look half an hour before sunup in early July. As the days pass, Venus also sinks into the Sun's glare. ☐

Deborah Byrd writes and produces the daily "Earth and Sky" radio series. Jeff Kanipe edits Star Date, *the University of Texas-McDonald Observatory magazine of astronomy.*

Off to See October's

Fiery prominences and brilliant diamond rings await eclipse chasers seeking totality in southern Asia.

by Fred Espenak

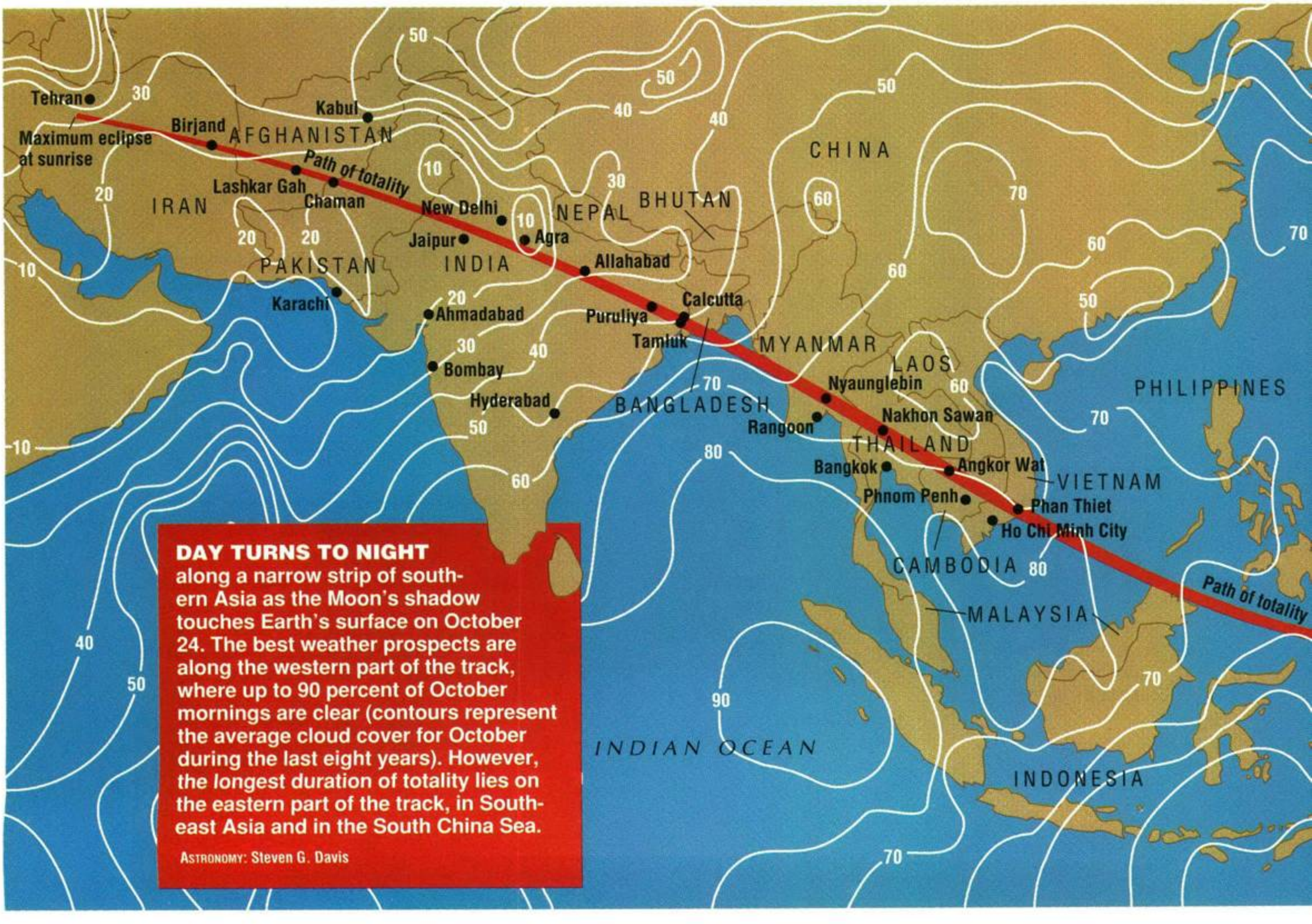
Despite having quenched their thirsts recently with a serving of corona in South America, eclipse chasers are already hungering for their next total eclipse of the Sun. Fortunately, they need wait only a few more months. Halfway around the world, the Moon's dark shadow will sweep across southern Asia and the western Pacific on October 24.

Recent total eclipses have had broad paths well over 100 miles wide, but this year's track is quite narrow, never exceeding 45 miles. As a result, totality lasts barely two minutes at best and is even shorter at some of the prime viewing sites.

Despite this being a rather short eclipse, such events offer observers a bonus: a better view of the Sun's chromosphere, prominences, and Baily's beads than long eclipses provide. These features will draw many eclipse chasers to the event, as will the fact that the next total eclipse won't occur until March 1997 over a Siberia still caught in the icy grip of winter.

October's eclipse path begins at local sunrise in central Iran and stretches across Afghanistan, Pakistan, and northern India. It passes just south of the Taj Mahal, where observers will experience a tantalizing partial eclipse with 99.7 percent of the Sun covered. Just north of the path lies Calcutta and its 11 million residents, who could witness a spectacular grazing eclipse.

Continuing to the southeast, the Moon's dark shadow, or umbra, crosses central Myanmar (formerly Burma), Thailand, Cambodia, and Vietnam. In Cambodia, the ancient ruins of Angkor Wat lie within the shadow's path and totality there lasts 1 3/4 minutes. A half hour later, the greatest duration of 2 minutes 10 seconds occurs in the South China Sea (latitude 8°24.6' N, longitude 113°


Tehran
Maximum eclipse at sunrise
Birjand
Kabul
AFGHANISTAN
Path of totality
Lashkar Gah
Chaman
IRAN
PAKISTAN
Karachi
New Delhi
Jaipur
Agra
INDIA
NEPAL
BHUTAN
Allahabad
Ahmadabad
Bombay
Hyderabad
Puruliya
Calcutta
Tamluk
BANGLADESH
CHINA
MYANMAR
Rangoon
Nyaunglebin
LAOS
Nakhon Sawan
THAILAND
Bangkok
Angkor Wat
VIETNAM
Phnom Penh
Phan Thiet
Ho Chi Minh City
CAMBODIA
MALAYSIA
PHILIPPINES
INDONESIA
INDIAN OCEAN
Path of totality
10
20
30
40
50
60
70
80
90

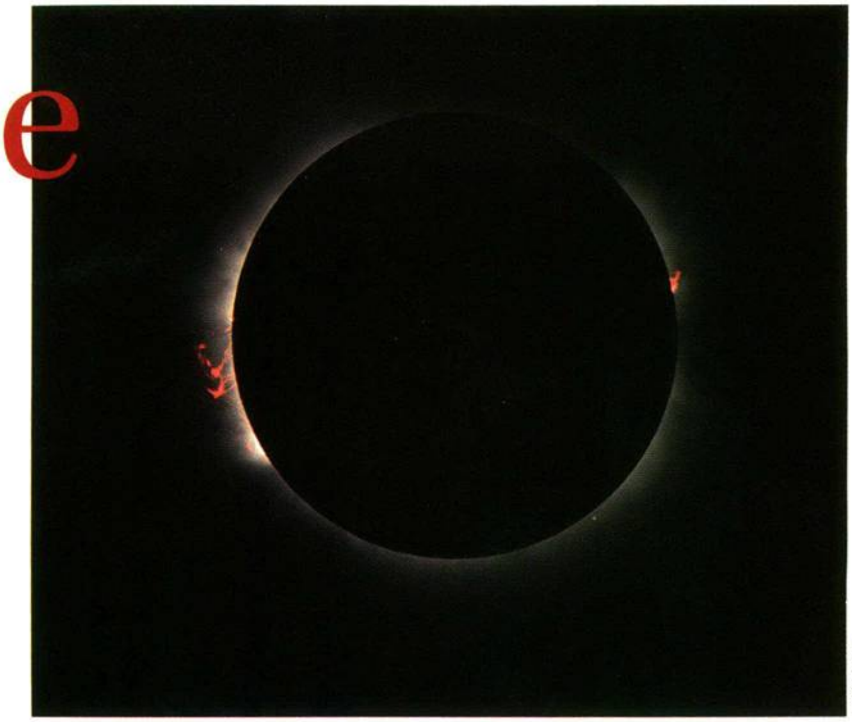
DAY TURNS TO NIGHT along a narrow strip of southern Asia as the Moon's shadow touches Earth's surface on October 24. The best weather prospects are along the western part of the track, where up to 90 percent of October mornings are clear (contours represent the average cloud cover for October during the last eight years). However, the longest duration of totality lies on the eastern part of the track, in Southeast Asia and in the South China Sea.

ASTRONOMY: Steven G. Davis

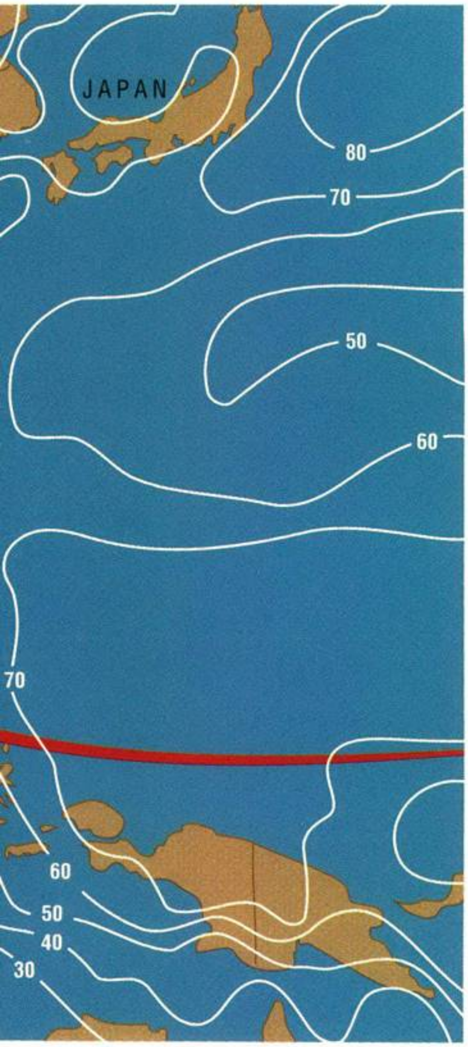
11.2' E). Shortly afterward, the shadow touches briefly the Malaysian state of Sabah on the island of Borneo before racing into the Pacific Ocean, where it leaves Earth's surface in Micronesia.

Where to Go?

In deciding which location offers the best view of the eclipse, would-be observers need to decide whether the duration of totality or the likelihood for clear skies is more important: The best weather prospects come in regions with the shortest eclipse. The eclipse track in the Middle East crosses areas that usually experience exceptionally clear skies, but totality lasts only a fraction of a minute and the Sun lies close to the horizon. On the other hand, Southeast Asia offers a Sun high in the sky and a duration


Rajiv Gupta

FIERY RED PROMINENCES and the Sun's ruddy chromosphere will be on prime display this eclipse because the Moon appears only slightly larger than the Sun, revealing more of our star's inner atmosphere and less of its outer atmosphere, the corona.

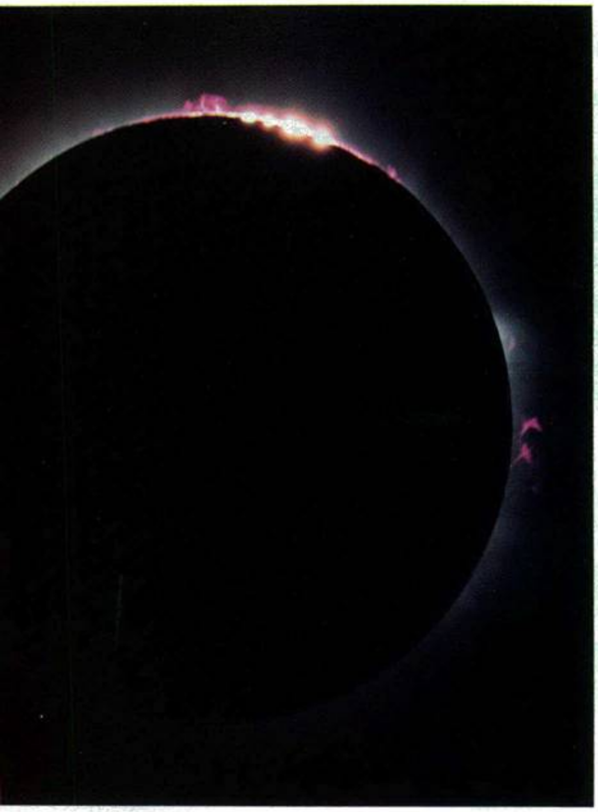


Local Circumstances for the Total Eclipse

Location	Eclipse Begins h m	Maximum Eclipse h m	Eclipse Ends h m	Sun Alt (°)	Eclipse Mag.	Duration of Totality
Iran						
Birjand	*	**02:54**	**04:00**	**7**	**1.007**	**0m17s**
Tehran	*	02:53	03:56	1	0.975	
Afghanistan						
Kabul	01:55	02:59	04:11	15	0.864	
Lashkar Gah	**01:53**	**02:55**	**04:05**	**12**	**1.008**	**0m31s**
Pakistan						
Chaman	**01:53**	**02:56**	**04:07**	**14**	**1.009**	**0m34s**
Karachi	01:52	02:56	04:07	17	0.830	
India						
Agra	01:55	03:05	04:24	27	0.997	
Ahmadabad	01:54	03:00	04:15	23	0.833	
Allahabad	**01:57**	**03:10**	**04:32**	**31**	**1.014**	**0m31s**
Bombay	01:56	03:01	04:15	25	0.715	
Calcutta	02:02	03:20	04:48	40	0.998	
Hyderabad	01:59	03:09	04:30	33	0.753	
Jaipur	01:54	03:03	04:21	25	0.983	
New Delhi	01:55	03:04	04:22	25	0.965	
Puruliya	**02:00**	**03:16**	**04:43**	**37**	**1.015**	**0m59s**
Tamluk	**02:02**	**03:19**	**04:47**	**39**	**1.016**	**1m09s**
Myanmar						
Nyaunglebin	**02:13**	**03:38**	**05:14**	**52**	**1.018**	**1m13s**
Rangoon	02:13	03:38	05:14	52	0.975	
Thailand						
Bangkok	02:22	03:51	05:30	59	0.962	
Nakhon Sawan	**02:20**	**03:48**	**05:26**	**57**	**1.019**	**1m45s**
Cambodia						
Angkor Wat	**02:28**	**04:00**	**05:40**	**62**	**1.020**	**1m48s**
Phnom Penh	02:31	04:05	05:45	65	0.972	
Vietnam						
Ho Chi Minh City	02:36	04:11	05:52	67	0.978	
Phan Thiet	**02:38**	**04:14**	**05:55**	**67**	**1.021**	**1m47s**

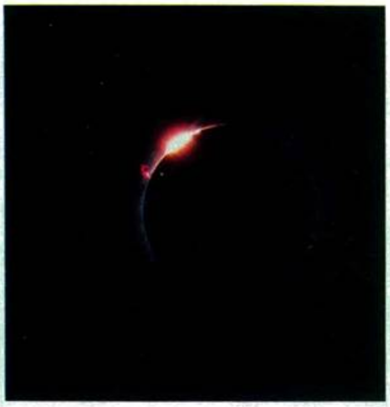
*** Eclipse is in progress at sunrise.**

All times are in Universal Time. Cities in red type lie in the path of totality.



Brenda Culbertson

BAILY'S BEADS SPARKLE like pearls on a necklace just before totality begins and just after totality ends, adding a touch of beauty to those moments.



Andreas Gada

DIAMOND RINGS SHOULD GLITTER with striking intensity during October's eclipse as sunlight streams through two deep valleys along the Moon's limb, right where the Sun will disappear and reappear.

approaching two minutes — but October comes near the height of the region's rainy season.

Satellite measurements of cloud cover help illustrate the problem. The map on the previous two pages shows eight years of data that have been averaged both through the day and over the month of October. Of course, no one gets "averaged" weather on eclipse day, but the statistics can serve as a guide to the relative merits of different locations along the eclipse track.

A barrier of mountains that wrings most of the moisture out of the air protects the path through Iran and Afghanistan, giving the region a semiarid climate and abundant sunshine. During October, Iran experiences sunny weather about 20 out of 31 mornings, and in parts of Afghanistan that rises to 28 out of 31 mornings. Unfortunately, the duration remains under about 30 seconds here, and the Sun stands less than 15° above the horizon. At such low altitudes, even a few clouds or a small amount of airborne dust will hurt eclipse visibility. The safety of tourists in such politically unstable regions could also give concern.

The Indian subcontinent is dominated by the hot, wet southwest monsoon, which brings lots of clouds and rain to the area during summer. By September, the northeast monsoon begins to bring cool, dry air from the north, which gradually replaces the moist air. The southwest monsoon has usually retreated into the Bay of Bengal by late October, immersing the entire eclipse path in the drier air. At that time, mean cloud cover typically falls below 10 percent for Pakistan and northwestern India. Few eclipse sites will ever offer better weather prospects than the Great Indian Desert along the Pakistan border. On the negative side, the Sun is still only 20° high and totality lasts a mere 44 seconds.

Across the Indian subcontinent, the Sun's altitude and the duration of totality grow rapidly, but so does the cloud cover. In Calcutta, the statistics show a 50 percent chance of clouds, although this value is skewed because it includes measurements made early in the month when the southwest monsoon exerts a stronger influence. If the summer monsoon is gone by eclipse time, the mean cloud cover in late October should be closer to 20 percent. With a duration of 1 minute 18 seconds just south of Calcutta, this locale looks attractive.

Nevertheless, eclipse trekkers should bear in mind that monsoons are notoriously fickle and can easily persist a week or two longer than normal. Pay close attention to local weather reports and make contingency plans in case it proves necessary to make a run for it at the eleventh hour. Under the circumstances, the best compromise between duration and weather is probably central India, from Jaipur to Allahabad.

October is also a month of transition across Southeast Asia: A northerly flow replaces the retreating southwest monsoon. Unfortunately, the northerlies are part of the trade winds and carry moist air from the warm waters of the South China Sea. Although these humid winds bring variable weather, October ranks as the wettest month of the year for much of Southeast Asia. The windward side of exposed coastal mountain chains in Myanmar and Vietnam receive the highest levels of clouds and precipitation. In contrast, sunshine is somewhat more abundant in the protected interior of Thailand and Cambodia, where the probability of clear skies during totality approaches 50 percent. Gamblers who beat the meteorological odds here will be rewarded with a duration of just under two minutes as the Sun stands 60° high.

As the path of totality tracks across the South China and Celebes seas, it enters a region noted for unpredictable showers and thunderstorms that often form in organized clusters, making them difficult to outrun should they appear on eclipse day. Because of a light southerly air flow, cloudiness decreases slightly to the east of Borneo. Eclipse cruise ships should find this location promising provided they are equipped to receive the latest satellite images and

For More Information

Fred Espenak and Canadian meteorologist Jay Anderson have prepared a detailed 82-page guide to October's eclipse: NASA Reference Publication 1344. It contains predictions, tables, maps, and weather prospects, and is available at no cost. Just send a 9- by 12-inch self-addressed stamped envelope with "Oct 1995" printed in the lower left corner, along with postage sufficient for 11 ounces (310 grams). Use stamps only; cash and checks cannot be accepted. Requests from outside the United States and Canada may use international postal coupons sufficient to cover postage. Send requests to Espenak at NASA/Goddard Space Flight Center, Code 693, Greenbelt, MD 20771. The October 1995 eclipse bulletin is also available over the Internet. Send e-mail to u32fe@lepvax.gsfc.nasa.gov for instructions.

can react quickly to position themselves under a clear sky.

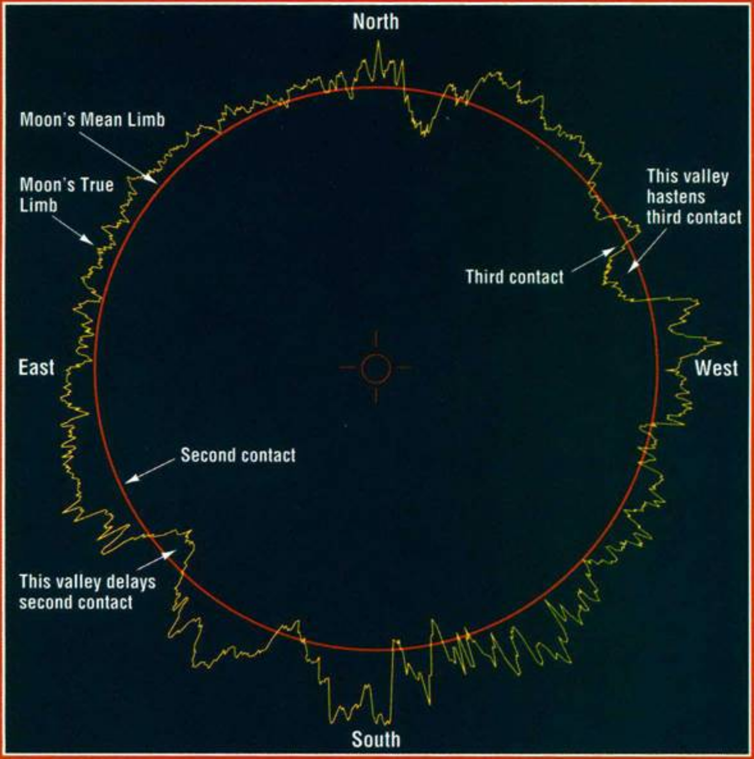
Current knowledge and understanding of weather prediction stands in sharp contrast to the science of celestial mechanics. Although we can calculate the time and duration of an eclipse from any point on Earth to within a fraction of a second, our ability to accurately predict tomorrow's weather is rather limited. Long-range weather prospects offer no guarantees of cloud-free viewing even for localities with excellent odds for clear skies. Even a favorable probability of 90 percent implies a 10 percent chance of failure, which could occur just as easily on eclipse day as at any other time. (Just ask anyone who traveled to Hawaii in July 1991.)

On the other hand, even locales with poor weather prospects can occasionally deliver the goods at the appointed hour. You need only look to past eclipses in Winnipeg (1979), Java (1983), and most recently Brazil (1994) to see that this is true. The lesson to be learned here is that meteorological statistics should only be used as a guide and not as some immutable rule in choosing an eclipse site. As meteorologist Joe Rao of AccuWeather in New York City is fond of saying, "Climate is what you expect, but weather is what you get."

The Great Centerline Myth

Once you've decided on a country, you'll want to choose your viewing site. The conventional wisdom among eclipse chasers is that the greatest duration of totality always occurs on the centerline. After all, an observer there sees the Moon pass directly across the center of the Sun.

But there's a small flaw in this logic: The Moon's limb is not perfectly smooth. It's actually quite rugged because of mountains, valleys, craters, and other geologic features. As a result, the serendipitous positioning of this topography can serve to either lengthen or shorten totality. Eclipse predictions rarely include these limb effects because they vary dramatically with distance from the centerline and with longitude along the eclipse path. Instead, an average lunar diameter is used to calculate the duration of totality. Usually, the limb profile changes the duration by only a few tenths of a second. But in the case of October's eclipse, the Moon's limb exhibits two deep valleys that conspire to significantly decrease the duration of an already short eclipse (see above).



ASTRONOMY: Steven G. Davis

TWO DEEP LUNAR VALLEYS cut into the length of totality seen along the centerline. If you want to see the longest possible eclipse, head several kilometers north so that the valleys won't lie so close to the points where the Sun disappears (second contact) and reappears (third contact) and the totality will be longer.

Go North of the Centerline!

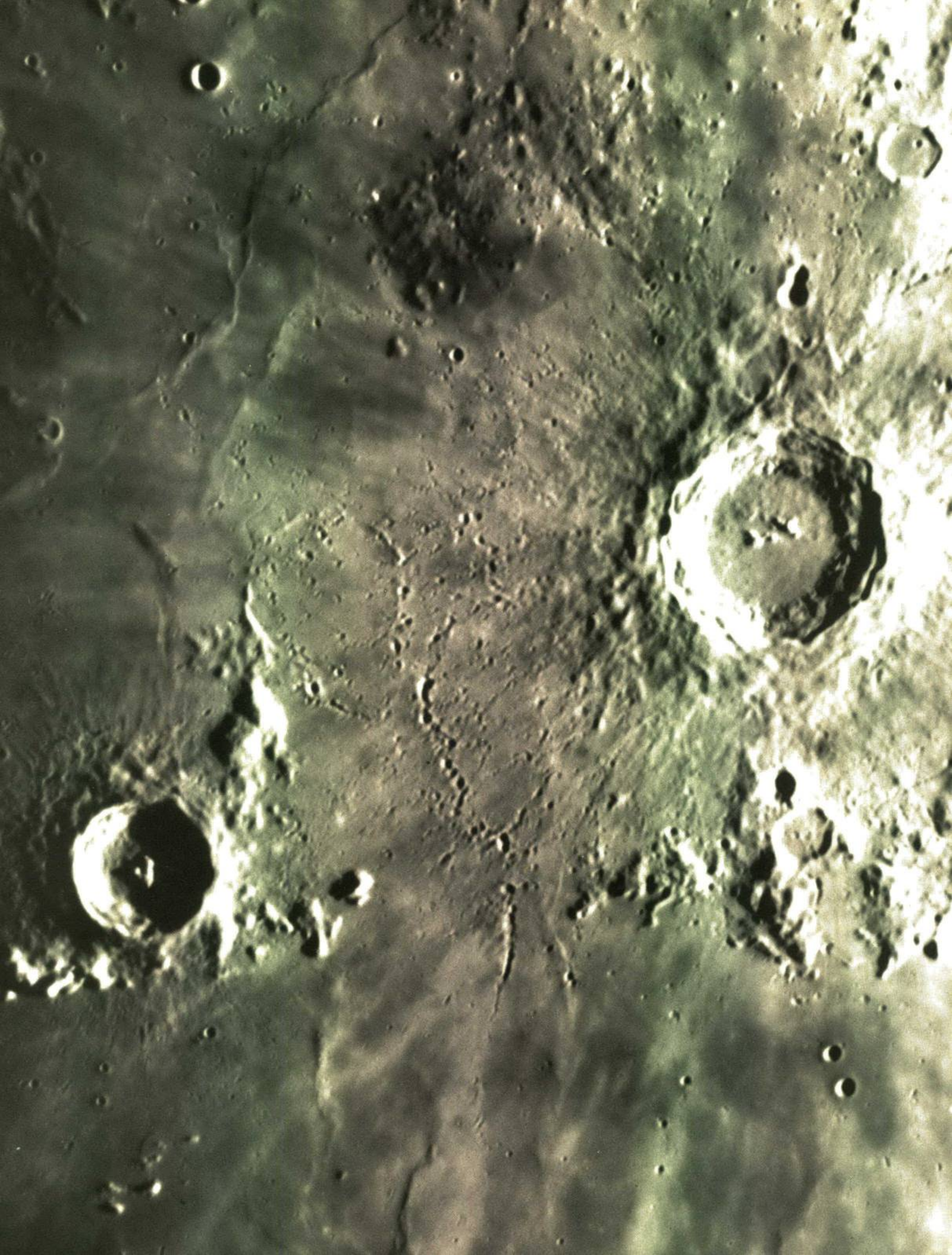
Universal Time	Center Line Duration*		Distance North of Center Line	Northern Maximum Duration*		Gain Over Center Line Duration
3:00	44.5s	(37.7s)	6 km	42.1s	(39.9s)	2.2s
3:15	70.8s	(62.8s)	8 km	67.4s	(66.4s)	4.4s
3:30	90.3s	(81.8s)	9 km	86.2s	(86.3s)	4.5s
3:45	105.6s	(96.8s)	9 km	101.8s	(101.8s)	5.0s
4:00	117.3s	(108.0s)	10 km	112.7s	(113.4s)	5.4s

*** Durations in () include the effects of the Moon's limb profile.**

The table tells the story for five spots along the Indian-Southeast Asia section of the track. The first column gives the Universal Time of maximum eclipse, and the second column gives the centerline duration of totality. The duration is calculated using a mean limb and the corrected duration including the effects of the Moon's limb profile is shown in parentheses. As you can see, the calculation using the actual limb profile shortens the duration by 7 to 9 seconds! That's a lot for an eclipse that already lasts under 2 minutes.

But that's not all. The duration of totality actually peaks 6 to 10 kilometers north of the centerline. This small shift is enough to partly offset the effects of the two deep lunar valleys without decreasing the centerline duration too much. Observers will actually gain 3 to 5 seconds of totality by abandoning their centerline positions and traveling a bit north. It's the only way to go for those eclipse chasers eager not just to sip totality this October 24, but to swallow as much of the intoxicating beverage as possible. ☐

An infrared astronomer at NASA's Goddard Space Flight Center in Greenbelt, Maryland, Fred Espenak will travel to India for the October solar eclipse.



Des Photographies Magnifiques de la Lune

Are the Best Lunar Photographers French?

Yes, many say. While most astrophotographers have been chasing deep-sky subtleties, the French have made art of Earth's closest neighbor.

by David J. Eicher

We've seen it in a hundred old movies — in the middle of the night, the clichéd Moon rising over the clichéd Eiffel Tower with lovers clichéing by and violins clichéing as the lovers pass the Arc de Triomphe. In reality, the Moon hanging over the French skies is no cliché at all. French astrophotographers tangle with it in a serious way, producing some of the finest portraits of our nearest celestial neighbor.

They gather their telescopes and gear, pack a few fresh rolls of high-resolution black-and-white film, and head for the mountains. The best of these photographers are Christian Arsidi, Jean Dragesco, Stéphane Dumont, J. Paul Roux, and Gérard Therin, all amateurs driven by a love of exploring the Moon's rich and varied surface. Three of the five, Arsidi, Dumont, and Therin, live in Paris. Dragesco lives in Montpellier, in far southern France near the Golfe du Lion. Roux lives in Lyon, on the Rhône River in southern France.

These men have blazed a trail by producing stunning lunar images. None of the equipment, choice of features, or high-quality film is exclusive to France — astrophotographers worldwide can purchase the same materials if the budget allows. So creating these magnificent lunar photographs like these is something others can aspire to.

THE RIM OF COPERNICUS CRATER (right, center), awash in sunlight, stands some two miles above the surrounding terrain. This crisp photo by Gérard Therin shows the crater Eratosthenes (left, bottom) and the remains of the ancient crater Stadius (left, center), an impact feature overrun by lava, which left behind a ghostly ring. Most small craterlets through the center of the photo resulted from debris hurled from the Copernicus impact. Therin used a 9-inch SCT at f/65, Tech Pan film, and a 1½-second exposure. Unless otherwise noted, south is at top in all photos, matching a telescope's view.

For telescopes, the astrophotographers choose top-of-the-line equipment, either large Schmidt-Cassegrains or high-quality refractors. Sizes range from a 5-inch apochromatic refractor to an 18-inch SCT. These designs provide a sharp, flat field and a long-enough focal length that the photographers can greatly magnify images. Details on the Moon's surface can be just a few arcseconds across (or less), so image quality is far more critical than it is with deep-sky photography: Galaxies, for instance, are 10 or 20 times larger.

The Moon has lots of light. But its brightness varies over the disk, so shooting small areas is easier than going for the whole disk. The brightness allows using eyepiece projection photography, which reveals small details. The technique requires that an eyepiece sit between the telescope's optical system and the camera to provide high magnification. Using a high-quality eyepiece that provides razor-sharp images is critical with this procedure. Several designs work well, including orthoscopics, Plössls, and Naglers, all of which these men use.

Four of the five photographers use fine-grain black-and-white film. The Moon doesn't offer much color, so it's not much of a loss to photograph it in black and white. And it so happens that black-and-white films are much sharper than color films because they are composed of finer film grains. Color film carries three layers of film grain sensitive to the three primary colors, and black-and-white film carries only one, which enhances its sharpness.

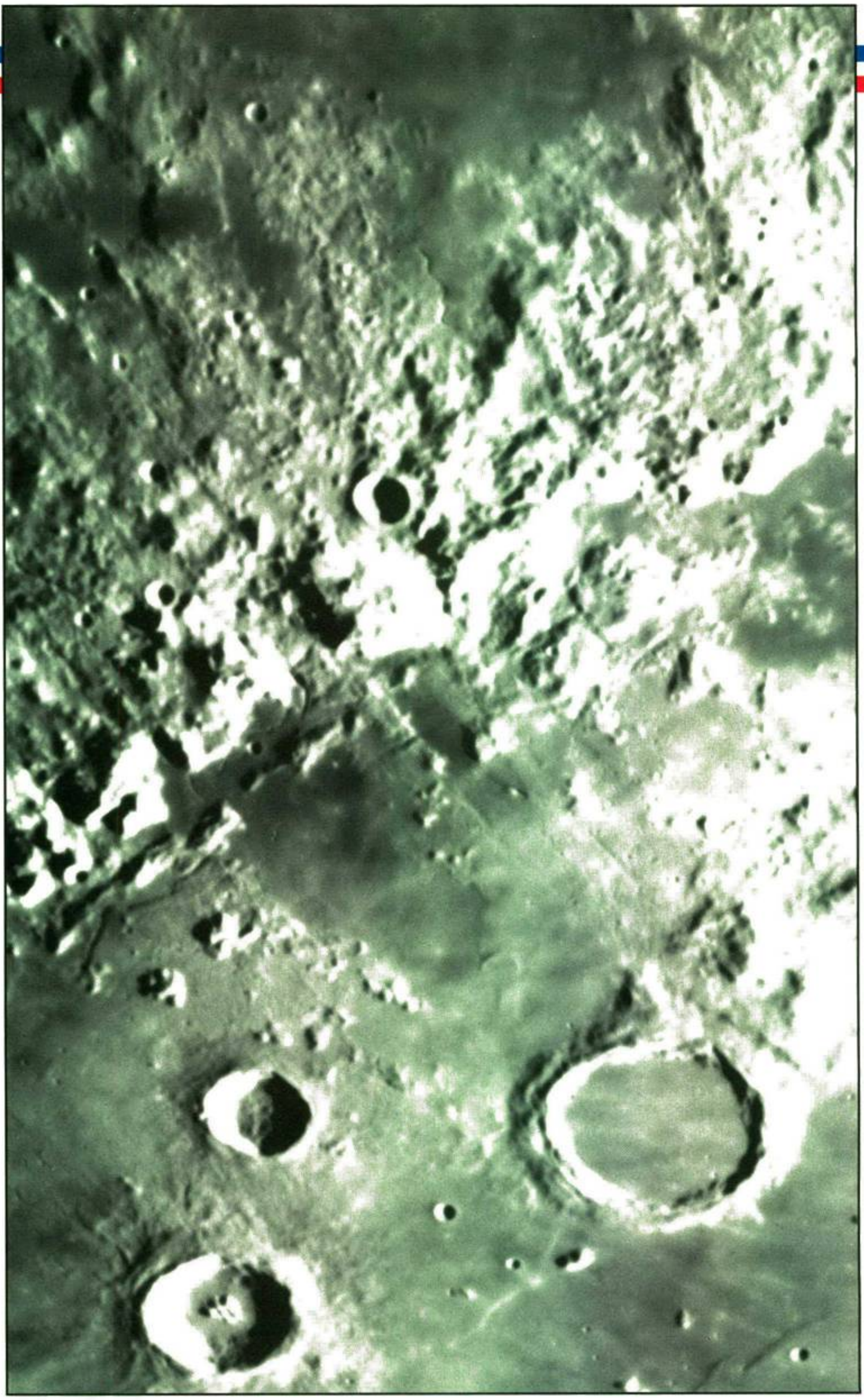
The sharpest of the black-and-white films is Kodak's Technical Pan 2415. It was developed for copying documents, but it is used by many astrophotographers because its extraordinary sharpness carries over well into capturing craters, rilles, and mountains. All but Dumont use it. He has entered the world of electronic imagery with an SBIG ST-6 CCD camera and routinely adds together ten 30-second exposures of moonscapes using his 9-inch SCT.

Sharp film and CCD chips alone will not do the trick. To make the most of imaging, all photographers strive to catch the Moon from sites featuring extremely steady seeing. These French photographers often travel to the Pyrénées, a superb area. When the air above the mountains flows smoothly, the seeing is relatively stable. (Heat and turbulence degrade telescopic images.) Mountain air is also *clean*. They want to avoid dust particles in the air, which can scatter moonlight and lower the contrast of an image.

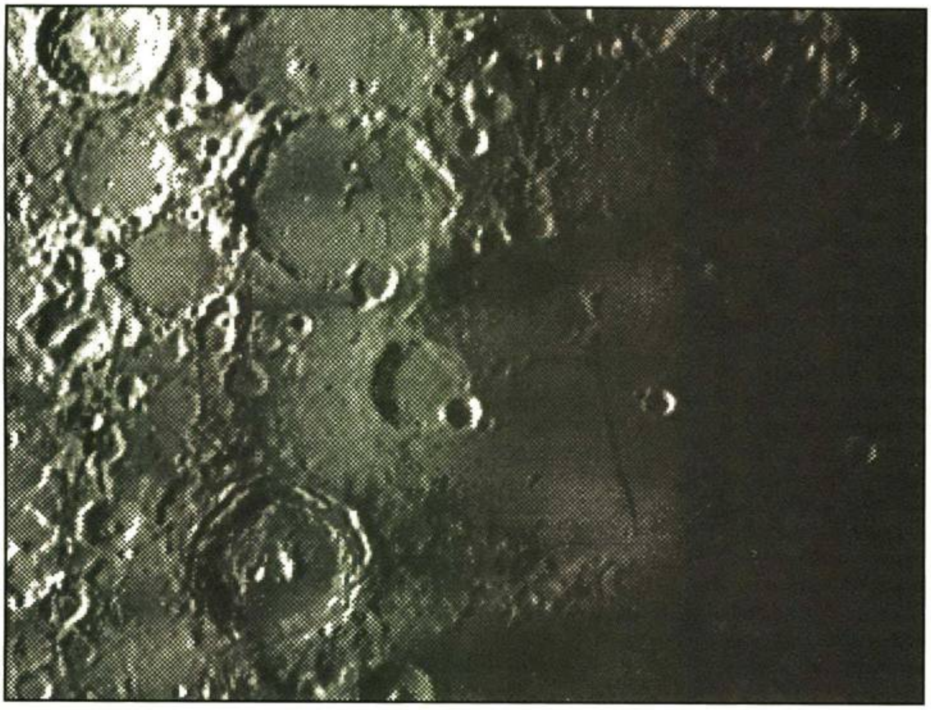
To get crisp shots, then, the photographers image the Moon only on nights when the seeing is steady and, even more critcal, on those nights they patiently wait for the moments of steadiest seeing.

The best way Moon photographers check seeing is simply by looking at a series of bright and faint stars or tiny features on the Moon at high power when the telescope has cooled to ambient air temperature. After doing this for a number of observing sessions, they learn to recognize a sharp, clean image. Atmospheric steadiness can vary over periods as short as seconds, so they need to monitor the view through the camera or a telescope as they wait to open the camera's shutter. This allows them to expose film during those moments of rock-steady seeing.

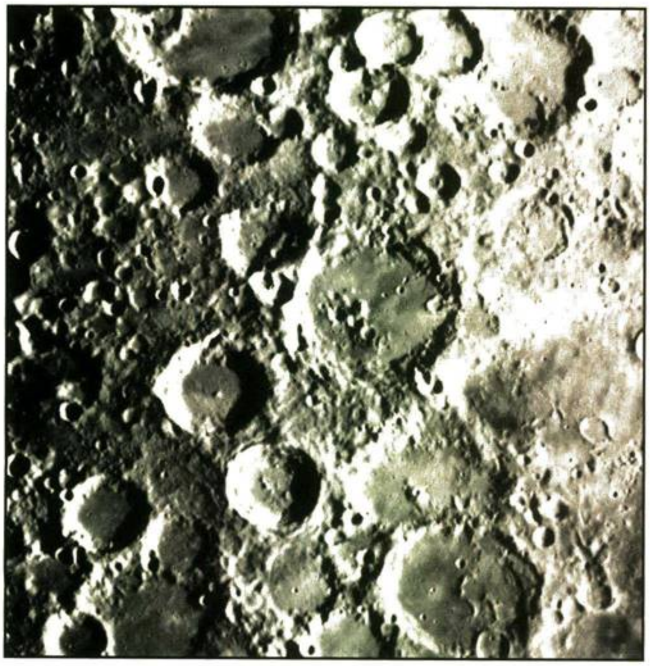
These men also wait for moments when the Moon's amazing network of features comes alive. At Full Moon, sunlight streams directly down on the Moon's face and comes right back at us. Features are lit harshly, and details appear washed out. But when sunlight strikes the Moon at a shallow angle, photographers can shoot craters, rilles, and mountains. This occurs when features are near the terminator, the line that divides night from day on the Moon. Sunlight washing over the Moon's



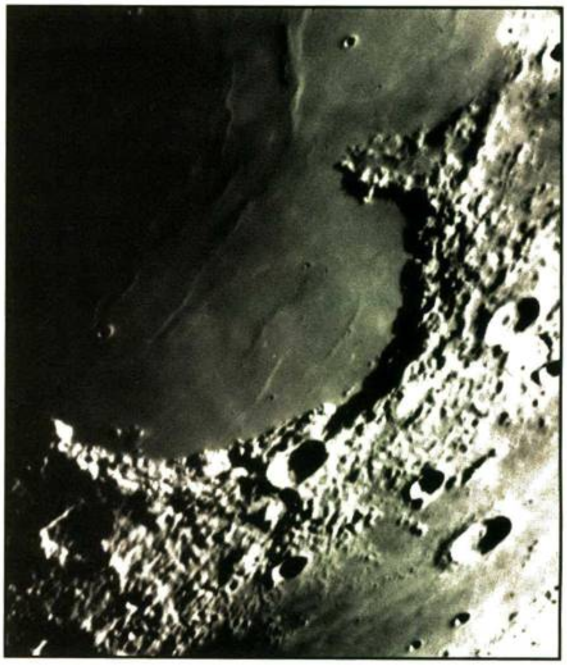
LIKE DIRT STUCK ON A BILLIARD BALL, the lunar Apennines rise above Mare Vaporum. Christian Arsidi's photo shows these towering mountains, the sunlit peaks of which are the highest points on the Moon, some topping 15,000 feet over the floor below. The triangle of craters at bottom consists of Aristillus (bottom left), Autolycus (top left), and Archimedes. Between Autolycus and the mountains lies the Hadley Rille, along which Apollo 15 landed. Arsidi used a 12-inch Cassegrain at f/48, Tech Pan film, and a 1½-second exposure.



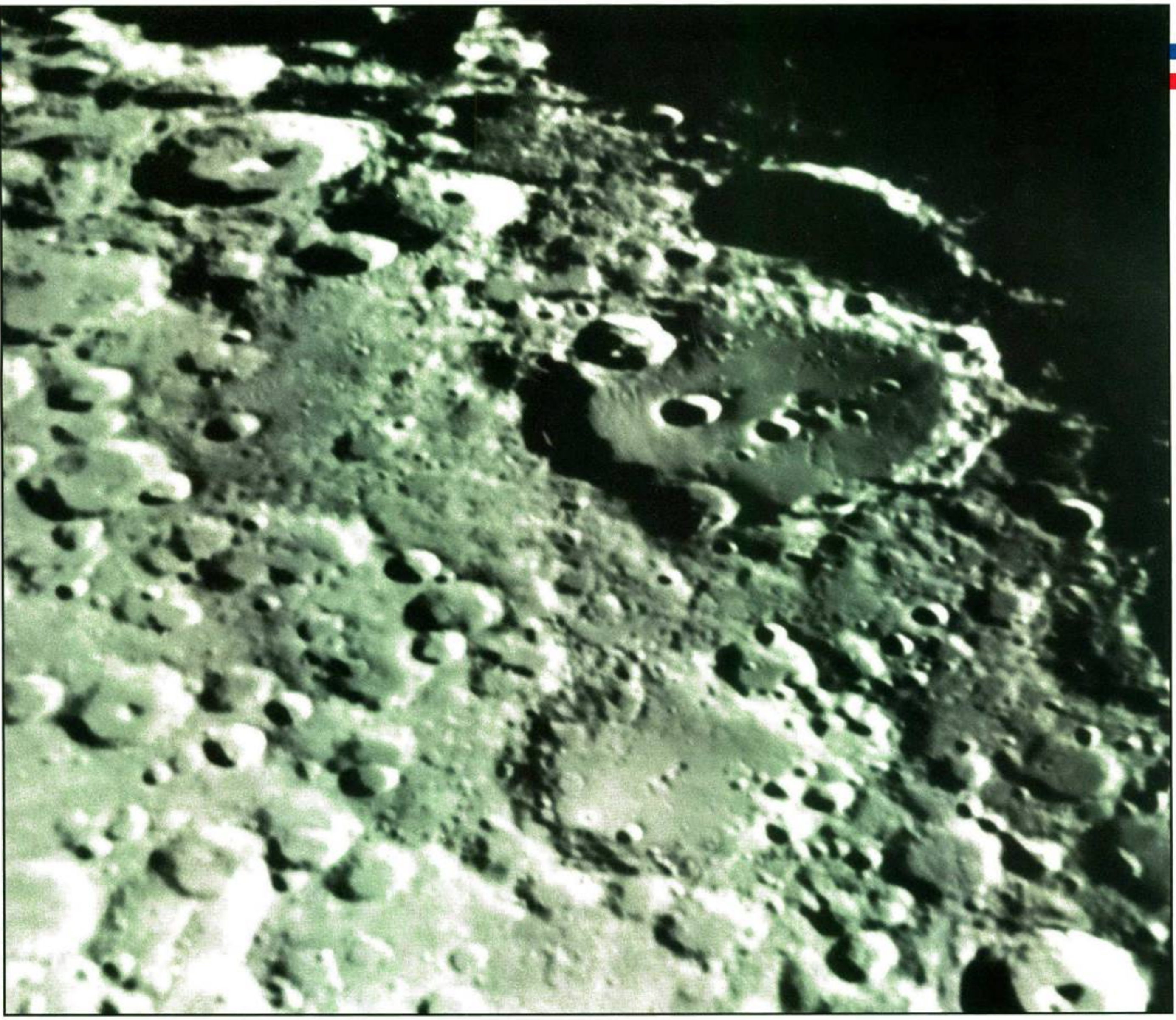
THE MOON'S MOST REMARKABLE FAULT, the Straight Wall (right, center) is a ridge 70 miles long, 2½ miles wide, and 900 feet high. Stéphane Dumont's image of the region shows the Straight Wall and craters in the highlands at left, most prominently Thebit (just left of center), Arzachel (bottom left), and Purbach (above and left of Thebit). Dumont used a 9-inch f/12 SCT and an SBIG ST-6 CCD camera to create a composite of ten 30-second exposures.



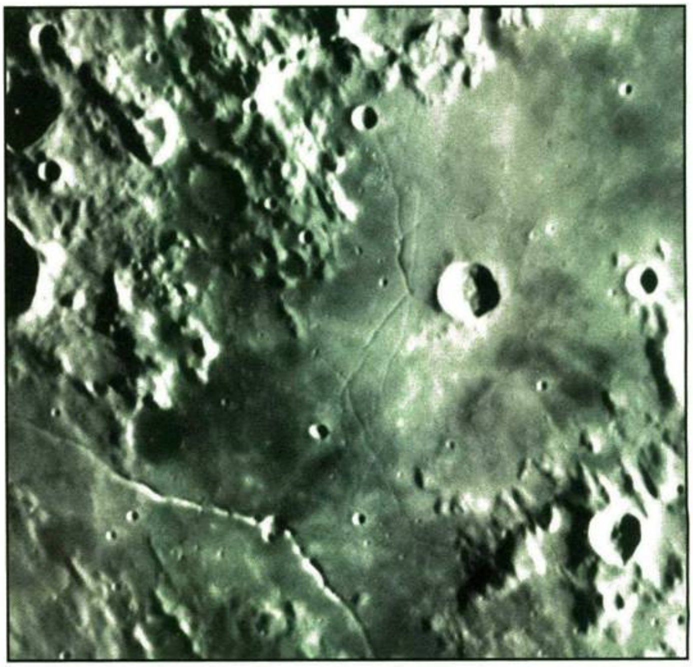
BATTERED BY COUNTLESS IMPACTS, the Moon's southern highlands provide observers with endless variations as the Sun's light moves across crater after crater. Christian Arsidi's photo depicts the north-south chain of large craters that passes through the image just right of center and includes (from the top) Stöfler, Fernelius, Walter (at center), Regiomontanus, and Purbach. Walter spans 90 miles and contains a cluster of four small craters. The north-south line of four smaller, prominent craters below center includes Aliacensus and Werner, whose eastern walls gleam with sunlight. Arsidi used a 12-inch Cassegrain at f/60, Tech Pan film, and a 1-second exposure.



AN ANCIENT CRATER FILLED WITH LAVA, Sinus Iridum is ringed by the Jura Mountains, which arc around the center of this image. Gérard Therin captured mare ridges rising from the floor of the basin, which spans 160 miles. The end of the arc just above center is Promontorium Heraclides. A short distance above and right of this point is the spot where Soviet scientists landed Luna 17 with its mobile laboratory. The other end of the arc, brightly lit by sunshine, is Promontorium Laplace. Therin used a 9-inch SCT at f/65, Tech Pan film, and a 1¾-second exposure.

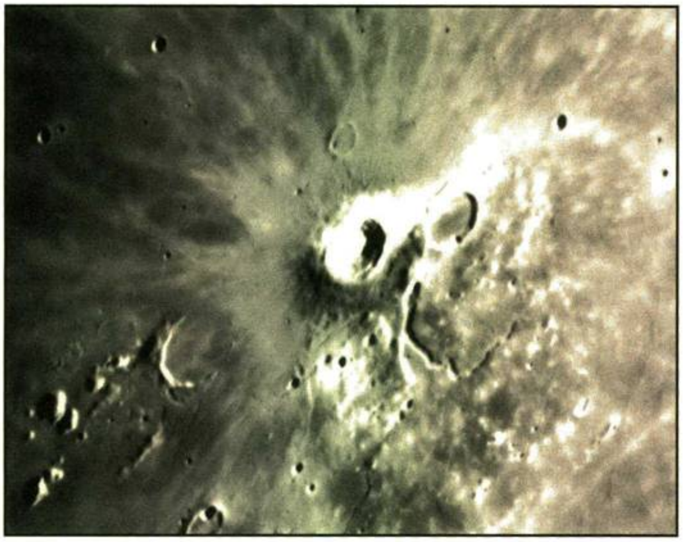


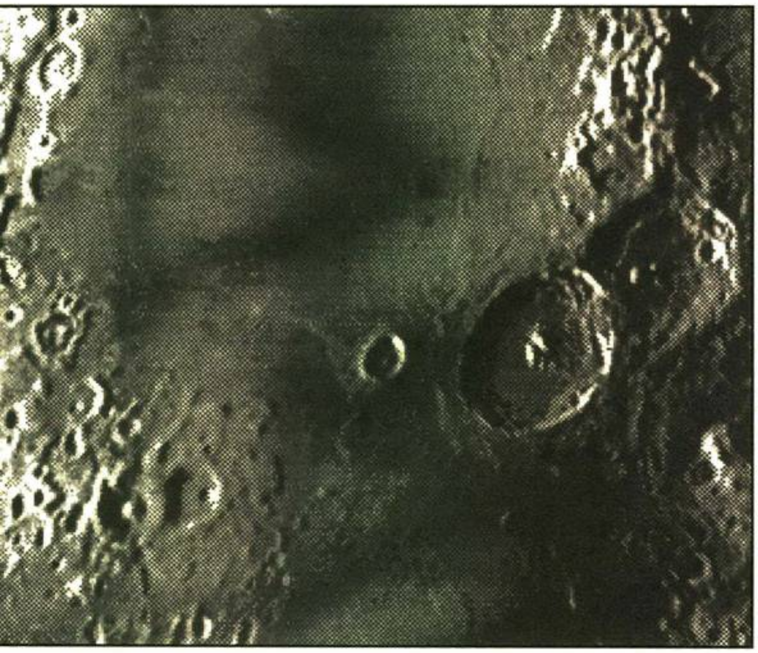
THE MOON'S SCARRED SOUTHERN HIGHLANDS are home to Clavius (right, above center), one of the best-known walled plains. Jean Dragesco's photo of the Clavius region reveals more than a dozen small craters inside Clavius, some of which offer a good test for seeing conditions. He also captures the craters Maginus (below Clavius) and Moretus (top left, with central peak). Clavius stretches 140 miles across. Dragesco used an 14-inch Cassegrain at f/45, 400 ISO film, and a 1-second exposure.



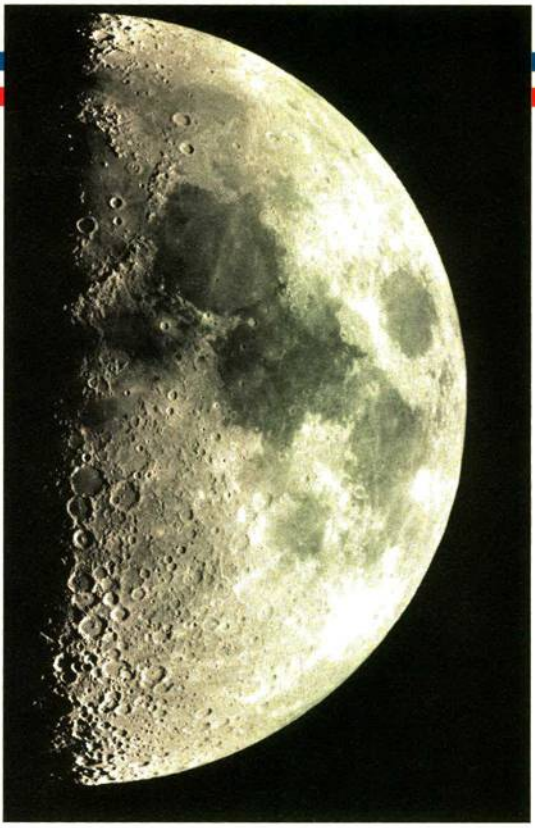
THE TRIESNECKER RILLES crisscross east of the small, prominent crater Triesnecker, right of center. This system is the most detailed on the Moon and stands out in a small telescope under good seeing. Christian Arsidi's portrait of the rilles shows the network's *full length of 125 miles.* Also visible is the more prominent southeast-northwest valley Hyginus, consisting in part of a crater chain. Arsidi used a 12-inch Cassegrain at f/48, Tech Pan film, and a ½-second exposure.

SURROUNDED BY RAYS, Aristarchus (below) is a bright crater some 25 miles across, with a 9,000-foot drop from the top of its walls to its center. Gérard Therin's photo reveals the bright ray crater Aristarchus (center), the flooded crater Herodotus (right of Aristarchus), and Schröter's Valley, which snakes northward from Herodotus. Schröter's Valley is the largest on the Moon, 100 miles in length, six miles wide in places, and a half mile deep in places. Therin used a 9-inch SCT at f/65, Tech Pan film, and a 1¼-second exposure.





THE SMOOTH, FLOODED PLAIN of Mare Nectaris (above center) contrasts starkly with the heavily cratered regions that surround it. Stéphane Dumont recorded the rich variety of features that include the craters Mädler (center), Theophilus (right, center), and Cyrillus (above and right of Theophilus). Mädler stretches 18 miles across — about the width of a large city. Dumont used a 9-inch f/12 SCT and an SBIG ST-6 CCD camera, and composited ten 30-second exposures.

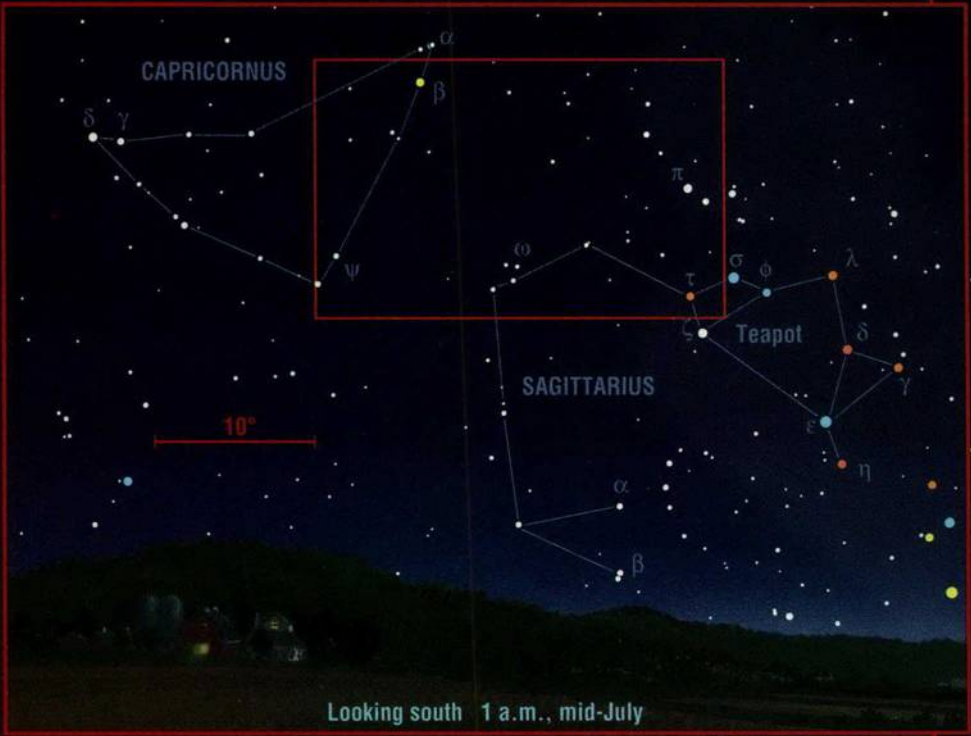


THE MOON AT FIRST QUARTER highlights the starkness of our nearest celestial neighbor. J. Paul Roux recorded crisp details of the dark blots of lunar maria and craters along the terminator, the dividing line between light and shadow. Roux used a 4.8-inch apochromatic refractor at f/17, Agfa Pan 25 film, and a 1-second exposure. North is at top in this photo.

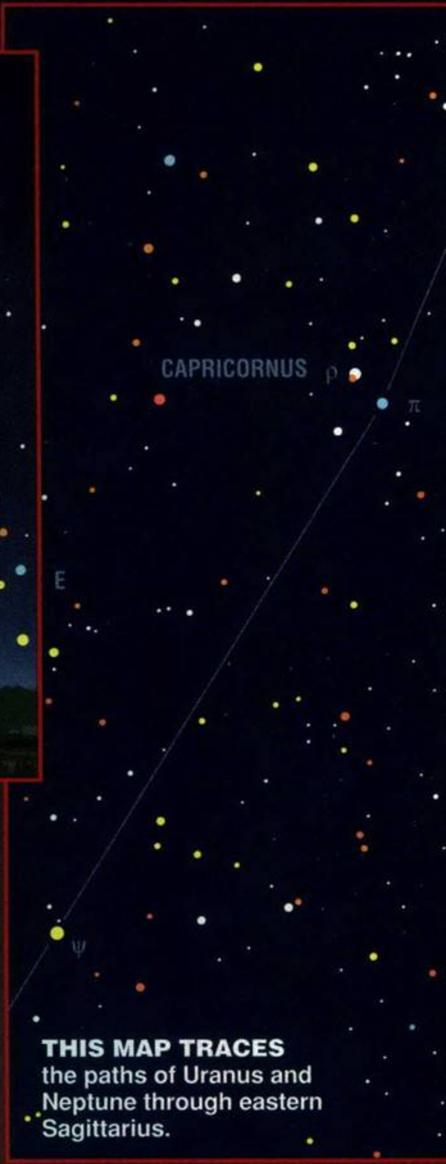
rugged surface at a shallow angle illuminates into bold relief domes, mountains, and central peaks in craters and results in deep shadows inside the walls of craters, behind mountain peaks, inside rilles, and behind ridges.

The five men have used this successful combination of equipment and technique to capture many popular regions on the lunar surface. They record the splattered region around the prominent crater Copernicus, where secondary craters form long chains of broken terrain, and the Straight Wall, a 70-mile-long fault near the dish-shaped crater Birt. They capture the large walled plains near the center of the Moon's face (notably Albategnius and Klein) and the hummocky terrain surrounding the lunar Apennines, which towers above Mare Imbrium. They image the bright crater Aristarchus, surrounded by a matrix of light rays sprawling from the impact site, and the sharp, sinuous Triesnecker rilles, fractures in the old solidified lava bed that supports them.

As these pages show, using well-tested techniques and focusing on the Moon's greatest attractions, these photographers offer superb images. Their techniques are available to everyone, Tech Pan film can be purchased in any country, and locations with good seeing know no national borders. The French have thrown down the gauntlet. Who's going to pick it up? ☐



Looking south 1 a.m., mid-July



THIS MAP TRACES the paths of Uranus and Neptune through eastern Sagittarius.

Uranus
Neptune

Greg Terrance

THESE DISTANT WORLDS are well within reach of binoculars and make tempting subjects for a summer observing session.

TARGET, URANUS AND NEPTUNE

Now's the time to hunt for these two elusive denizens of the outer solar system.

by Richard Talcott

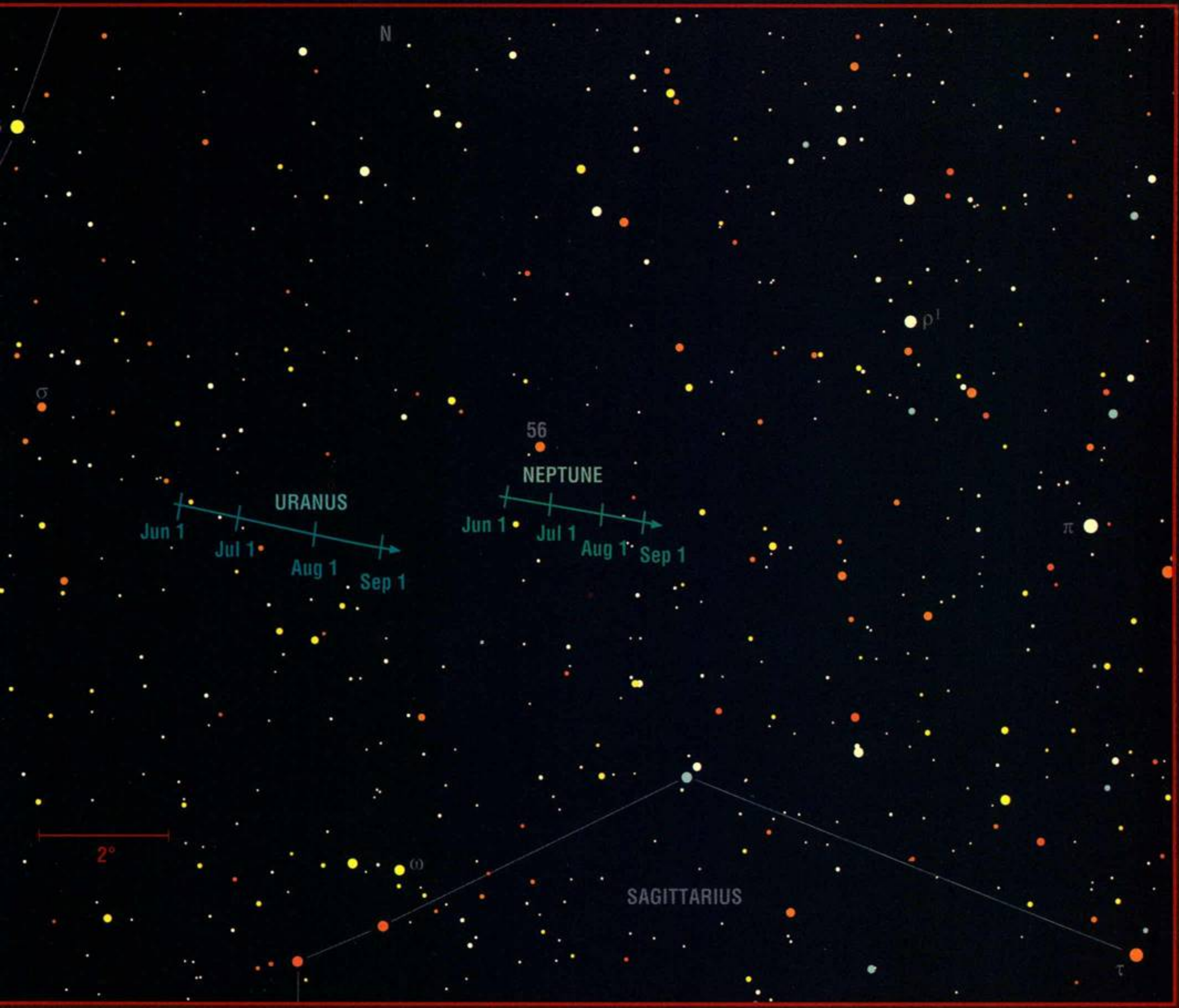
They're roughly the same size, the same composition, the same color. And this year, they're in roughly the same area of sky. *They* are Uranus and Neptune. This summer backyard observers have a great opportunity to spy these two gas giant worlds as they brighten in the evening sky.

Uranus and Neptune often represent a beginner's first foray into the fainter members of the solar system. The bright planets — Venus, Mars, Jupiter, and Saturn — are easy to find when at their best, and normally elusive Mercury can appear conspicuous if you catch it at the right time. But Uranus and Neptune require some effort even at their best and, in the case of Neptune, some optical aid. The key to finding them is knowing when and where to look.

July offers the best viewing prospects of the year. The planets reach opposition (lie opposite the Sun in our sky and remain visible all night) within five days of each other around midmonth. Opposition also marks their closest approach to Earth, which makes them appear brighter than at other times.

Uranus, the nearer and brighter of the two, shines at magnitude 5.6, placing it just within grasp of the naked eye. Neptune, somewhat dimmer at magnitude 7.9, requires some optical aid, though even a pair of 7x35 binoculars will bring it into view as a starlike point of light.

The two planets lie within about 5° of each other throughout the summer months, making it easy to spot both in a single binocular or finderscope field of view. And their proximity to several bright stars and two easily recognizable star patterns helps you zero in on the right area quickly. The hard part is pinpointing which of the myriad points of light are the



Astronomy: Steven G. Davis

planets: They lie among the background stars of eastern Sagittarius, one of the more densely populated regions of the sky.

First, use your naked eye to find the famous Teapot asterism in Sagittarius. During July this group of nine 2nd- and 3rd-magnitude stars lies fairly low in the southeast as darkness falls and nearly due south around midnight. Next, locate the group of three stars located about 5° above the "handle" of the teapot. Then shift your gaze 10° due east from there to the star 56 Sagittarii, which marks the jumping-off point for Uranus and Neptune. (You then should be roughly halfway between the teapot in Sagittarius and its eastern neighbor, Capricornus.)

To locate the planets, you'll want to search with a pair of binoculars and use the map above as a reference. The map shows the positions of the planets from early June to early September, when the two are brightest and thus easiest to find.

Now zero in on the 5th-magnitude star 56 Sgr. Uranus lies about 5° east and 1° south of this star in mid-July. Remember that at magnitude 5.6, Uranus shines significantly brighter than any star in its immediate vicinity. Once you've found Uranus in binoculars, set them aside for a moment and look for the planet with your naked eye. If you have good eyesight and observe from a dark site, you should be able to spot it. If you don't, look a little to the side of the planet's position. This averted vision uses the rods in your eyes, which are more sensitive to faint light, and can make the difference between seeing and not seeing it.

Once you've found Uranus, go back to 56 Sgr and scan 1° south and a bit west. That's where you will find Neptune in mid-July. Because it glows a full magnitude brighter than the faintest stars shown on the map, you should be able to pinpoint it simply by locating the object that doesn't belong among the background stars.

If you're still unsure whether you've seen the planets, the easiest way to confirm the sightings is with a telescope. Center each object in the scope's field of view; then insert a high-power eyepiece. If the object appears as a small disk and not as a point of light, then you're looking at a planet.

Uranus offers a 3.7"-diameter disk that appears blue-green and Neptune measures 2.3" across and sports a faint blue-gray color. Despite being giant worlds measuring over 30,000 miles across, they appear small because you are viewing them across more than a billion miles of space. The reward in finding Uranus and Neptune is not in seeing rich detail in the eyepiece, but in gazing on the most distant major planets in the solar system. □

Have Sketchpad, Will Travel

Ebony pencil
EF Eberhard Faber DESIGN™ EBONY JET BLACK EXTRA SMOOTH 6325
Sanding pad for sharpening pencils
NO 6 MADE IN TAIWAN R. O. C.
Smudge stick
HB or #2 pencil
Protractor
POST
1532A

In an era when film and CCDs greedily gobble up light from the cosmos, don't forget to reserve a few photons for you and your trusty sketchpad.

By Scott Mitchell

Any hobby is a form of self expression. What better way is there to enjoy deep-sky astronomy than to apply a full measure of creativity? Some observers do this through astrophotography, while others insist on a different medium: drawing.

In its purest form, a drawing conveys precisely what the mind sees, an observer's expression of experience. Beyond that, a drawing is a result of the eye's amazing range of sensitivity and the mind's powerful ability to integrate and interpret. We have at our disposal not only the equivalent of an ultra-sensitive camera, but the world's most complex self-aware and self-teaching computer.

Seen in that light, drawing has two rewards: ultimate self-expression, and with practice and the right tools, an accurate record of what's seen in the eyepiece. Most people have no trouble with the self-expression part: It's "learning to draw" that stops them before they start. But learning to draw becomes quick and easy once it's broken down into steps. Besides, in its role as self-expression, there's really no such thing as a bad drawing.

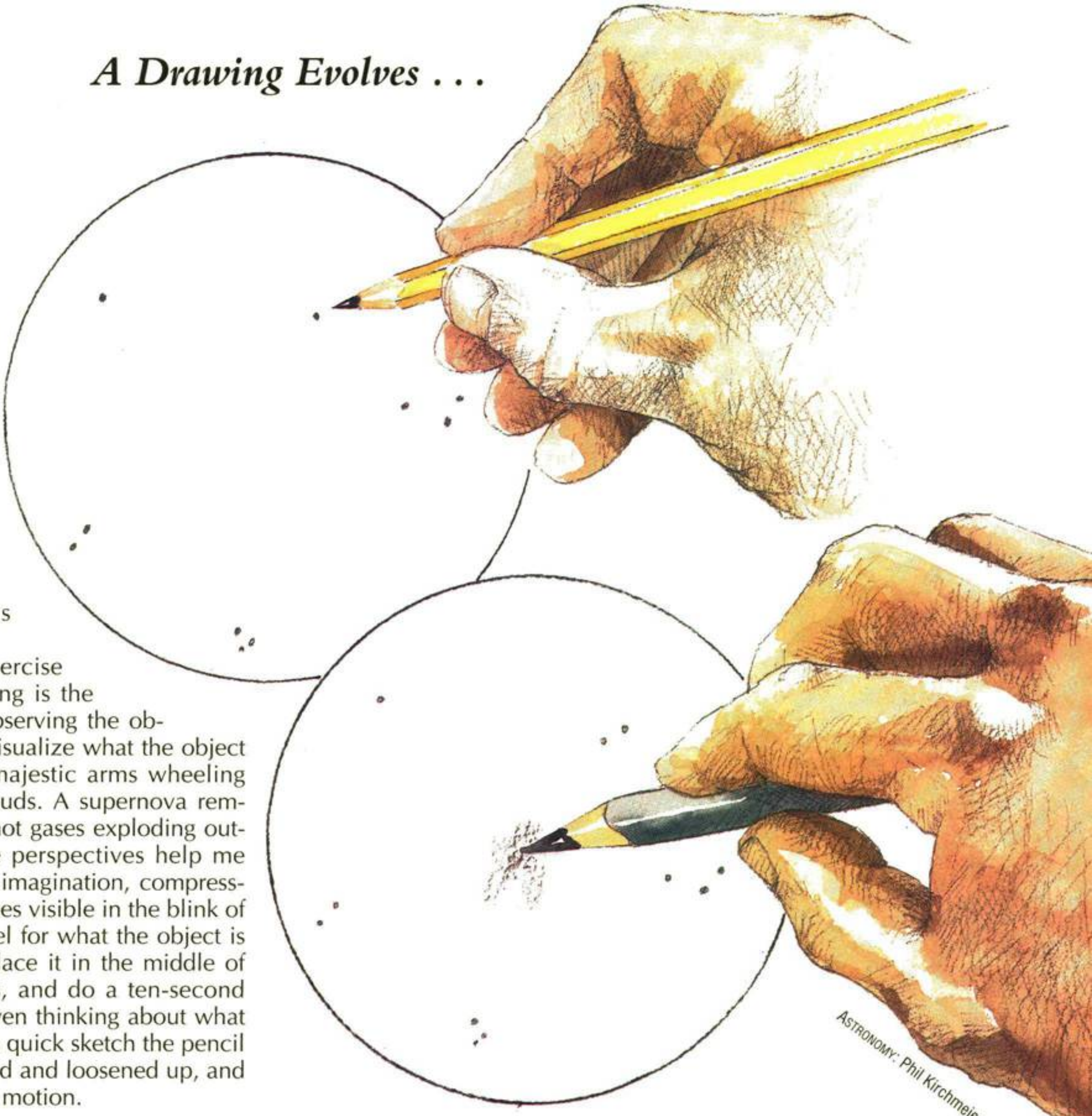
Poetry in Motion

Accomplished artists all work by one axiom — In order to draw, first observe. Professional artists and backyard observers are headed in the same direction with their sketchpads and pencils: They eye a subject, grasp a vision, and in a particular moment draw what that vision means. The more drawing is done, the easier it becomes to see things. In astronomy, a trained eye turns the axiom on its head: To better observe, draw.

So the first and foremost rule of astronomical sketching is look carefully and then draw only what's seen. Study the object intently before even picking up a pencil. Try different eyepieces to see the most detail or select filters to enhance contrast. With deep-sky objects, use averted vision (looking off to the side of the object while still observing it). This reveals different parts of the object. Fasten your mind on the entirety of the object, its general shape, its contours, and its movement.

Its *movement?* Exactly. What distinguishes a globular cluster rendering from a random swarm of dots on paper is your ability to convey what is really happening with that object. In the classic text, *The Natural Way to Draw*

A Drawing Evolves . . .



Step 1
Box object with stars

Step 2
Sketch major details

ASTRONOMY: Phil Kirchmeier

(Houghton Mifflin Company, 1941), Kimon Nicolaides instructs, "Draw not what the thing looks like, not even what it is, but what it is doing."

One Nicolaides drawing exercise I've applied to deep-sky drawing is the preliminary fast sketch. After observing the object intently in the eyepiece, I visualize what the object is doing. A spiral galaxy has majestic arms wheeling through dust lanes and star clouds. A supernova remnant like the Crab Nebula has hot gases exploding outward in far-flung blasts. These perspectives help me "fast-forward" the object in my imagination, compressing time so its movement becomes visible in the blink of my mind's eye. Once I get a feel for what the object is doing, I take pencil in hand, place it in the middle of one of some pre-drawn circles, and do a ten-second sketch of this motion without even thinking about what the object looks like. During this quick sketch the pencil is never off the paper; I'm relaxed and loosened up, and complete the sketch in one fluid motion.

Get Ready to Draw

Mastering this technique is half the battle; the other half lies in preparation. As with regular observing, the more preparation done before a drawing session, the better the results.

First, make a list of objects to sketch and then devote at least one page of the sketchbook to each object. Using a 3- to 4-inch circular guide (try a jar lid), draw circles that represent an eyepiece's field of view. Somewhere on the page write down the targets' technical details taking the information from an object catalog: any Messier or NGC designations, magnitudes, sizes, and/or any special features.

Before heading out to the scope, don't forget to pack a flashlight fitted with a red filter. Red light won't ruin night vision that's crucial to making accurate drawings of faint objects.

Once in the field, as evening fades into darkness, rate the atmospheric seeing (air stability) and the transparency (star clarity) on a scale of 1 to 5, one being very poor, five being the best. After I've done that, I usually make a simple naked-eye sketch of where the object appears in its related constellation, noting the object's height above the horizon.

After finding and centering the object in the eyepiece, establish a drawing's east/west orientation by watching which way the object drifts (if you own a clock-driven telescope, do this by turning off the drive). In the eyepiece of an undriven telescope, objects move from east to west.

Pencil to Pad

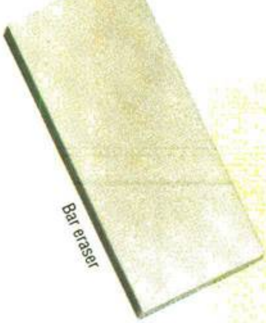
Now it's time to do the sketch. At this point, most budding artists start off on the wrong foot by laboring over a detailed patch of one section of the object.

A much better approach is to first draw a pattern of brighter stars that surround the object. These stars serve as guideposts that keep the drawing's proportion and spacing correct.

Next, launch into a fast sketch to capture general shape. This later serves as a template when it comes time to fill in any subtle detail in the object's shape.

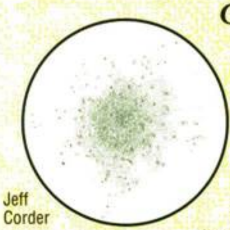
Then, with a soft-leaded Ebony pencil or charcoal stick, rough in the object's area of greatest star density. In a globular cluster, it might be the central core. In an edge-on spiral galaxy, it could be the narrow disk con-

Ink pen for permanent stars

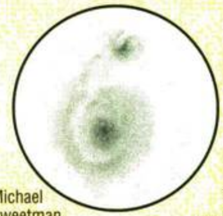


Special Objects, Special Techniques

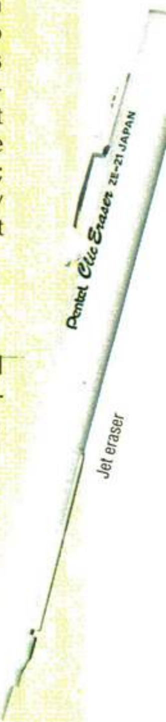
Pencil sharpener

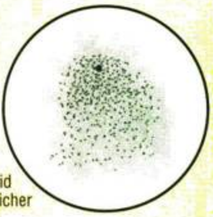

Jeff Corder

Globular clusters. These are a lot of fun to draw because they are so rich in detail. First "box in" the globular with the foreground star pattern. Then make a light gray central zone with an Ebony pencil or charcoal. Using circular motions with a smudge stick or fingertip, work the core outward until the edges fade naturally and have no discernible border. This is the central core of unresolvable stars. Next, place any resolvable stars. One approach to this is to circle the cluster's rim with the brightest stars and slowly work to the center. This assures placing them accurately according to magnitude without your getting hung up in one sector. To do justice to any globular, you must place the stars as precisely as possible, even if it seems as tedious as counting microbes through a microscope. Don't get carried away and resort to madly peppering the cluster with stars at random.

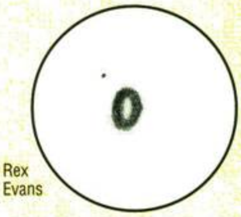

Michael Sweetman

Galaxies. The sheer variety of galaxy shapes, sizes, luminosity, and orientation guarantees that each sketch will stand out. With an Ebony pencil or charcoal, rub the paper using the side, not the point, to produce a gray smudge that represents the central area of the galaxy. With most spiral galaxies, this mark will be an elongated bar; with elliptical galaxies, a circular shape; with irregular galaxies, almost anything. Then, using a smudge stick or fingertip, draw out the further reaches of the galaxies. Don't bother putting more graphite or charcoal on these outer extensions; smear all that's needed from the central core. Remember to get a sense of what is moving in that galaxy and how the spiral arms sweep around, and then let your smudge stick recreate that motion. Use the jet eraser to show any dust lanes.




David J. Eicher

Open star clusters. Accurate placement of stars really counts here. There is all the difference in the world between the solitary citadels of the stars in loose clusters and the silver dust sprinklings that make up richer clusters. Some astro-artists advocate a fine-tip pen for open clusters. But I think a pencil works better than a pen because a pen cannot convey gradations of brightness. Capture the general shape of the cluster, the magnitude and color of its stars.


Rex Evans

Planetary nebulae. With the exception of real show-stoppers like the Ring (M57) in Lyra or the Dumbbell (M27) in Vulpecula, these little devils lack visual detail, sometimes resembling unobtrusive little blobs floating out in the middle of nowhere. The challenge of planetaries is to accept this lack of detail and just draw what's there. Many of the subtle shading techniques that apply to galaxies work here.

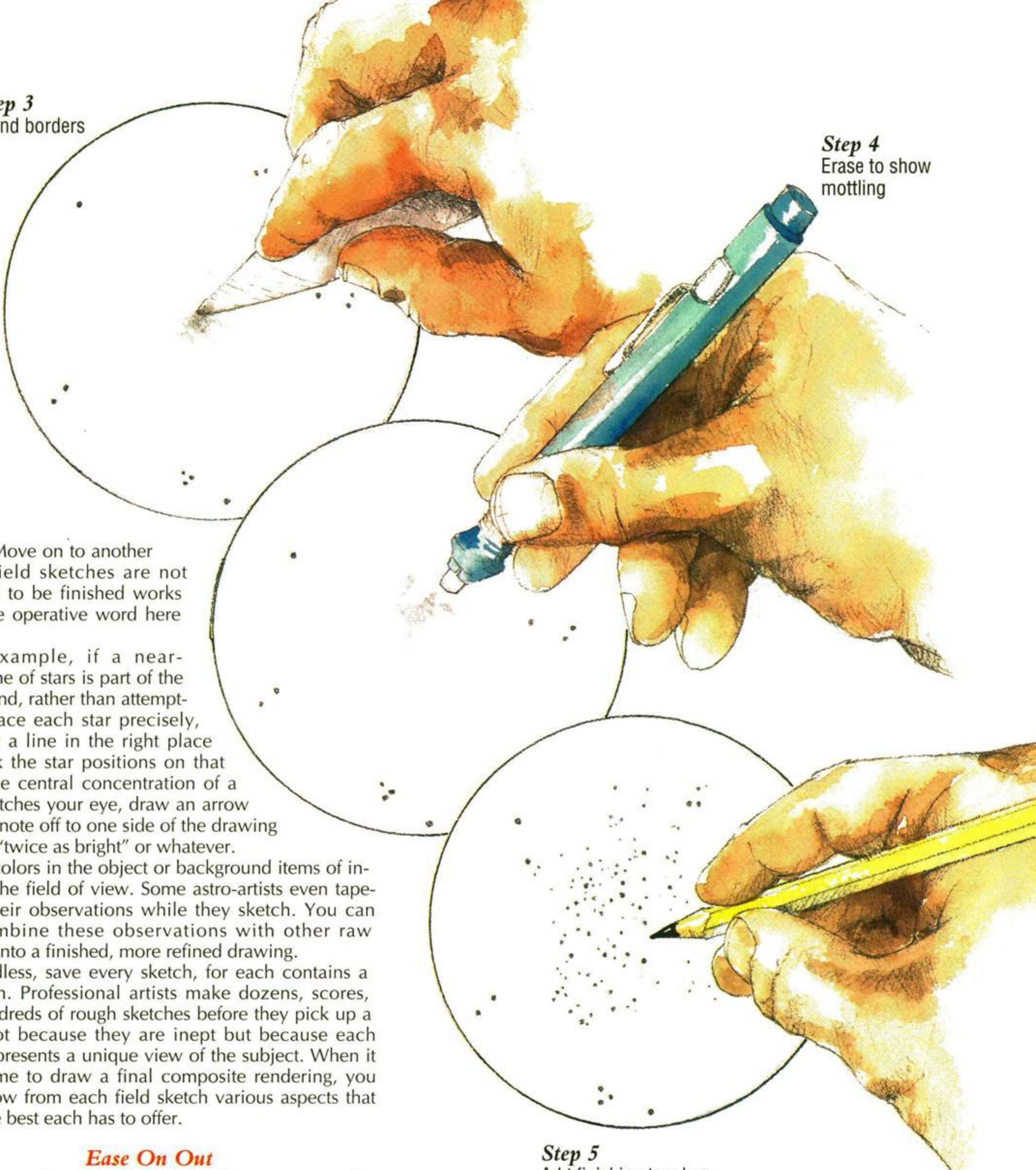
taining its arms. Now put the pencil or charcoal aside and use a smudge stick (or a fingertip) to smudge the layer of graphite or charcoal that marks the area of greatest luminosity. Soon there's a good representation of the haziness seen through the eyepiece. Smudging recognizes that there are few straight lines and neat borders in deep-sky objects.

But there *is* detail. Now's the time to add all refinements to the basic sketch: the glittering of stars resolved in globulars, the dark dust lanes that split the silver band of light in a galaxy, or the abrupt cut-off that divides a dark nebula from a sea of background stars.

This is also the time to use every available optical aid. Again, try different eyepieces, play off higher magnification for greater definition, or use filters to enhance contrast. You'll find an experienced eye comes into play here as well; studying the object with intense concentration and using averted vision reveals more and more detail.

While dividing attention between the eyepiece and sketchpad, preserve as much night vision as possible by keeping your red light subdued. Limit exposure to light by spending most of your time studying the object, and then draw bits of remembered detail in short bursts.

If you make a mess of the first sketch, don't try to salvage it through painstaking restoration and furious



erasing. Move on to another circle. Field sketches are not supposed to be finished works of art; the operative word here is *rough*.

For example, if a near-perfect line of stars is part of the background, rather than attempting to place each star precisely, just draw a line in the right place and mark the star positions on that line. If the central concentration of a galaxy catches your eye, draw an arrow and jot a note off to one side of the drawing that says "twice as bright" or whatever.

Note colors in the object or background items of interest in the field of view. Some astro-artists even tape-record their observations while they sketch. You can later combine these observations with other raw sketches into a finished, more refined drawing.

Regardless, save every sketch, for each contains a little truth. Professional artists make dozens, scores, even hundreds of rough sketches before they pick up a brush, not because they are inept but because each sketch represents a unique view of the subject. When it comes time to draw a final composite rendering, you will borrow from each field sketch various aspects that reflect the best each has to offer.

Ease On Out

When you have finally drawn all you can see, be sure to protect the sketch either by spraying fixative on it or by putting it in a secure, dry place.

The next day, while the lingering memories of the night before are still fresh, fold all the elements into a composite drawing. Once the composite drawing is finished, compare it to photographs or notes made by other observers. Nothing in the world of deep-sky drawing quite matches the fun of laying your sketch of an obscure NGC object alongside someone else's drawing or photograph for comparison.

As important as any telescope or binoculars is to observing, so should the sketchpad and pencil be, for they are powerful tools in the quest to appreciate deep-sky objects. Where astrophotography preserves an image, only an eyepiece drawing accurately records what is *really* seen through a telescope. A drawing is more than an astronomical field-sketch. It becomes a whole new way of looking at the cosmos and your location in it. ☐

By day, Scott Mitchell is an attorney who lives in Houston, Texas.

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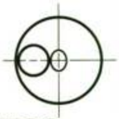

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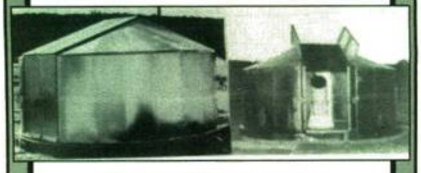

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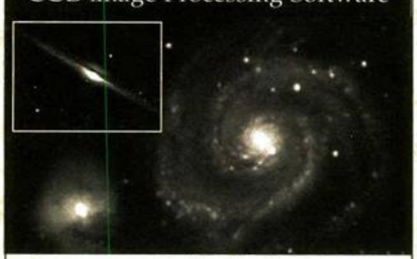

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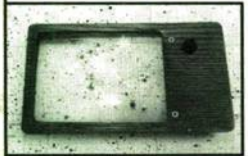

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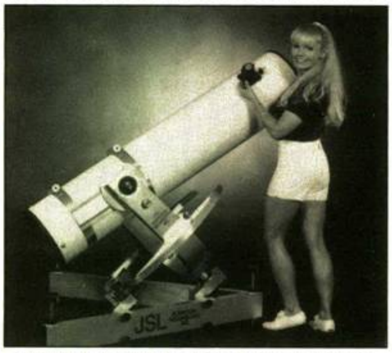

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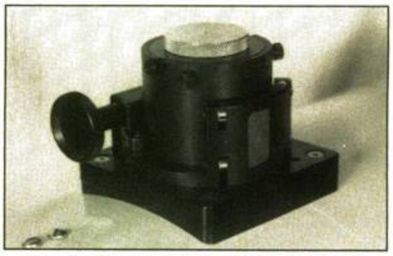

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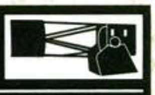

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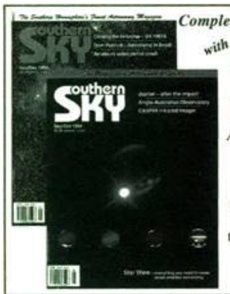

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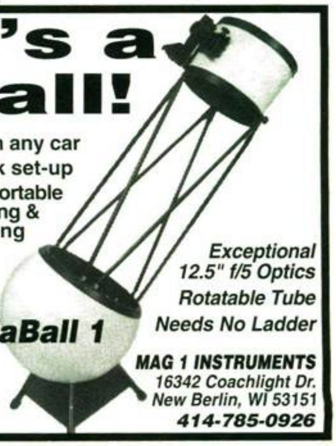

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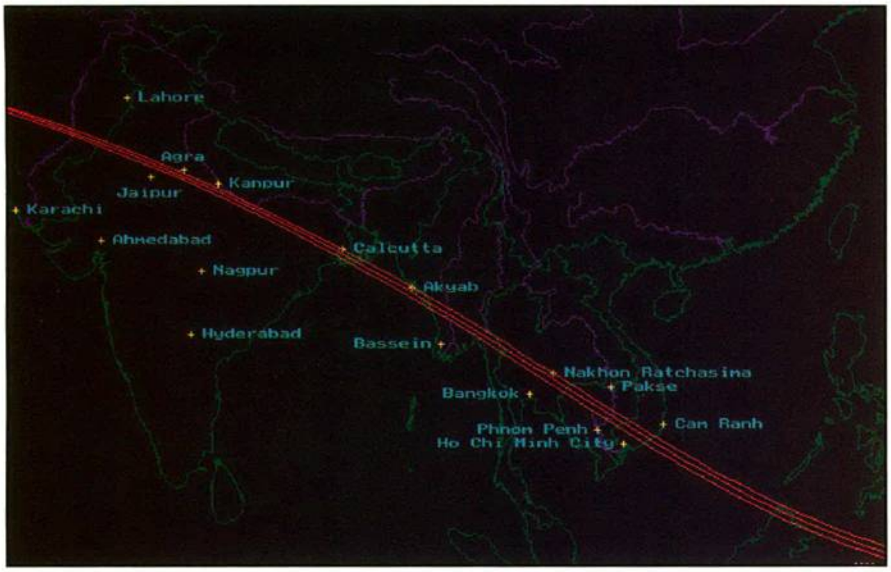


October 1995 solar eclipse mapped by *EclipseComplete*

EclipseComplete 2.0

by Charles Kluepfel, available from Zephyr Services, 1900 Murray Avenue, Pittsburgh, PA 15217, (800) 533-6666, fax (412) 422-9930. Price: $149.95. Minimum requirements are an IBM PC-compatible computer and a CGA display. The developer recommends a hard drive.

EclipseComplete provides information on future and past eclipses of the Sun and Moon. Users can study an individual eclipse or the way eclipses repeat every 18 years (the Saros period). Eclipse chasers can investigate the best places to view an upcoming eclipse, and home-bound eclipse viewers can find out how much of the eclipse they can see. The program will display eclipse information such as duration, magnitude, and position of the Sun or Moon or save it as a text file for later examination.

It will map the path of a solar eclipse or the regions on Earth where observers can view a lunar eclipse. These maps can use conic, polar, and rectangular projections to give the most realistic view of a particular eclipse's path. Users have great control over the map's size, title, centerpoint, printed orientation (landscape or portrait), grid style for latitude and longitude lines, and the colors of various features such as labels, lakes, rivers, and country borders. Maps can include city and country names using two supplied name files or a user-created file. Maps can be printed on a laser or dot-matrix printer using gray scales instead of colors or saved as a PCX-format file for use in other programs.

This DOS-based program uses a menu bar to access various features.

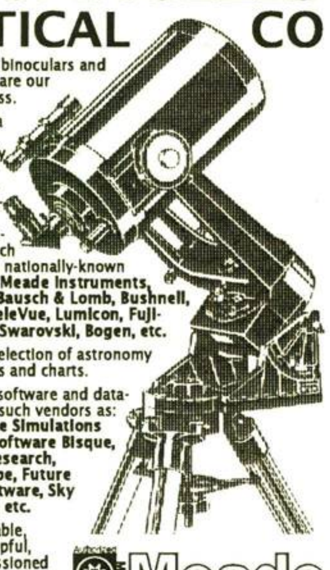
The manual provides detailed information about how to create an eclipse map. Although some of the steps produce displays that can be intimidating at first, the user doesn't need to know much about their details. The developer intends these displays for advanced users who want to check the accuracy of eclipse predictions and study their circumstances.

EclipseComplete also has the ability to plot the circumstances of occultations, events during which a planet or the Moon passes in front of another planet or a star. The program can't predict these events, but it can show where the occultation is visible on Earth if the user knows the event's time and position.

Binary Star

Gemini Software, 502 Holly, Fayetteville, AR 72703, (501) 442-4159. Price: $37.50. Minimum requirements: Macintosh computer, System 7.X, color display, 2 MB of memory. Gemini Software recommends a 68040-based computer.

Binary star systems in which one star periodically eclipses the other are fascinating celestial objects because the light outputs of the systems change in myriad



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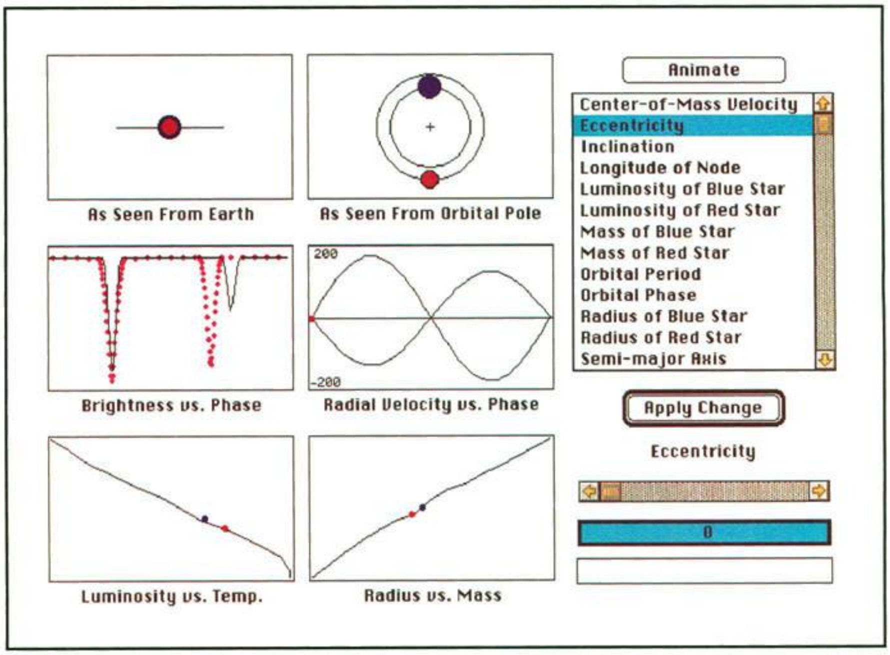

Study star systems using *Binary Star*

ways. *Binary Star* uses a simple control screen for building a double star system containing stars of different masses, temperatures, and luminosities. The user can also select the size and shape of the stars' orbits. Six windows show plots of the stars' orbits from the side and above, the change in the combined brightness of the stars as they orbit, the velocities of the stars in their orbits, and physical characteristics of the stars (luminosity, temperature, radius, and mass).

Ten data sets provide users with actual data for trying their hands at reconstructing what binary star systems look like. Two manuals provide information to help determine the orbits and characteristics of the stars using the data provided. Several practice files isolate individual variables such as the inclination of the stars' orbits to give users experience in manipulating the model of the binary system. Such simple tasks lead to a greater understanding of what causes binaries to change their light output in complicated ways. The technical manual references the data sources for the binaries investigated and lists reasonable fits to the data sets included with the software so users can check their solutions.

Voyage to the Outer Planets
NRSPACE Software, P.O. Box 30864, Seattle, WA 98103, (800) 548-7766, fax (206) 783-9296. Price: $49.95. Minimum requirements: 33-megahertz 80386-based PC, 4 MB of memory, Windows 3.1, Super VGA display, double-speed CD-ROM drive, and a sound card.

Voyage to the Outer Planets is a set of two CD-ROMs that provides interactive tours of Jupiter, Saturn, Uranus, and Neptune and the satellites of these planets. It also permits the user to view nearly 2,000 images taken by the Voyager spacecraft of the outer planets and their satellites.

Disk one contains the tours of the planets and the main software. The tours are multimedia presentations using text, images, video, and audio. (The program uses the video and audio programs from Windows.) One tour provides information about the Voyager spacecraft. The software includes an image browser that permits viewing 2,000 images on the second disk. Users can zoom in and out on an image using a histogram, control its brightness and contrast, or change the black-and-white display to one using false colors.

The image browser can also read images from the 10-disk set of Voyager images produced by the National Space Science Data Center. Called *Voyagers to the Outer Planets,* these disks contain more than 45,000 images of the outer planets. The entire set costs $110 and is available from NSSDC, Code 633.4, Goddard Space Flight Center, Greenbelt, MD 20771 (e-mail request@nssdca.gsfc.nasa.gov). ☐

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ASTRO BOOKS

Getting to Know the Universe

The Alchemy of the Heavens
Ken Croswell (Anchor/Doubleday, 1995), ISBN 0-385-47213-7, 376 pages, hardcover, $24.95.

For the most part, the Milky Way remained "terra incognita" until the beginning of the twentieth century. It was the development of photography that put astronomers on the road to understanding our Galaxy by giving them the ability to see farther and thus gather more data.

In *The Alchemy of the Heavens* Croswell, a Harvard-trained astronomer who is now a full-time science writer, takes the reader on a journey discovering the Milky Way, synthesizing what is now known about our home Galaxy and showing how this knowledge has been built up through astronomical research and debate.

He begins with Jacobus Kapteyn's conception of the Galaxy as a small, cozy place with a diameter of 55,000 light-years. But it was not long until Harlow Shapley used Cepheids to envision a much larger galaxy and Edwin Hubble gleaned the true nature of other galaxies, demonstrating that the Milky Way and the universe were not one and the same.

During the first two decades of the century Enjar Hertzsprung and Henry Norris Russell independently developed the color-magnitude diagram that now bears their names, giving astronomers a tool to aid them in their understanding of the Galaxy's stars. In the 1920s Gustaf Sternberg, Bertil Lindblad, and Jan Oort showed that the Milky Way rotates.

During the following two decades Walter Baade advanced the notion of stellar populations, one of the great breakthroughs in understanding the Galaxy, and William Morgan used photography to show that the Galaxy has spiral arms.

The 1950s saw the publication of the monumental paper by Margaret and Geoffrey Burbridge, William Fowler, and Fred Hoyle on how all the heavier elements could have arisen in the stars. This is the alchemy referred to in the title of this book.

From this point, Croswell leads the reader into the dispute over the origins of the Galaxy. On one side Allan Sandage and colleagues maintain that its genesis

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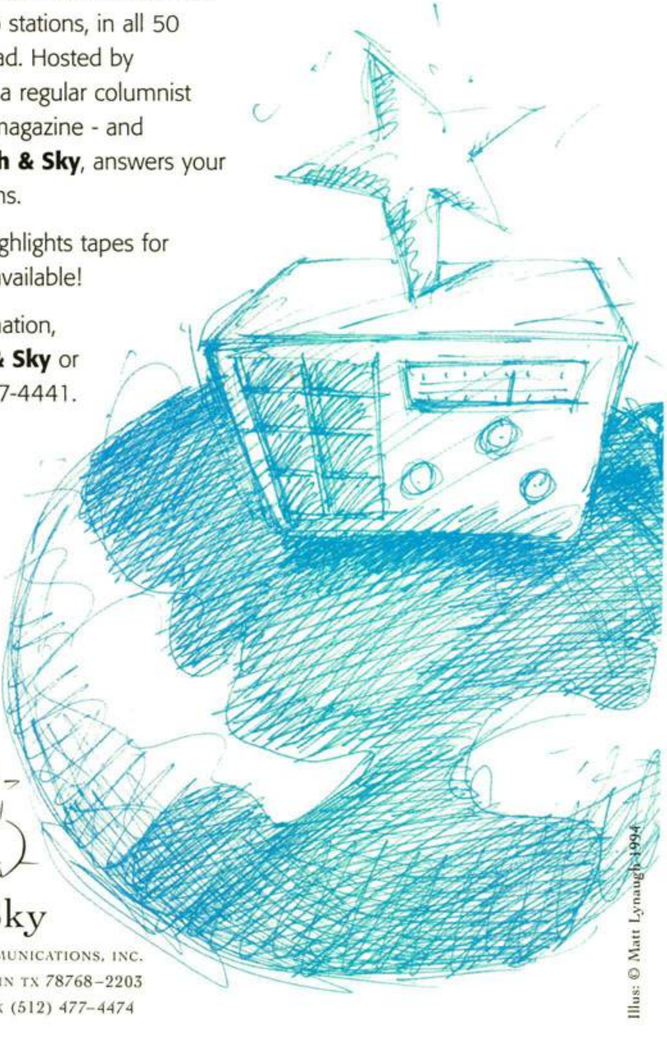

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was smooth and orderly. The other side, represented by Leonard Searle and Robert Zinn, proposes that the Milky Way formed in a chaotic manner.

More recently there has been considerable controversy over the exact nature of the Galaxy's disk. New Zealander Gerard Gilmore reported a new stellar population that forms a thick disk above and below the thin disk, providing a new view of the Milky Way's past and fueling the debate over the Galaxy's origin.

After visiting that area of contention, Croswell then considers what is known of the galactic center (that bulge that has been difficult to penetrate) and the Galaxy's frontiers (the satellite galaxies and the dark matter outside the disk of the Milky Way).

He also reviews how knowledge of the Milky Way has shed light on the age of the universe and has influenced the current battle over the Hubble constant (see "How Far to Virgo?" March 1995).

Croswell finishes the book by examining the requirements for intelligent life in the universe and the likelihood that we may be the most technologically advanced species in the Milky Way.

The Alchemy of the Heavens is a careful, objective account aimed at general readers, but some sections, especially those about recent research, may prove heavy going for the uninitiated.

Nevertheless, Croswell has produced an excellent synthesis of current knowledge on the Milky Way, made all the more interesting by first-hand interviews instead of the usual synopsis of scientific papers. — *Stephen H. Peters*

Review the first chapter and table of contents of The Alchemy of the Heavens *on the Internet at:* http://dab.psi.net/chapterone/astronomy

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Paul Davies, (Simon and Schuster, 1995), ISBN 0-671-79964-9, 320 pages, hardcover, $24.

Paul Davies examines both philosophically and scientifically how humans have conceptualized time since the ancient Greeks. Folded are the ramifications of Einstein's theories of relativity, in which time as we perceive it seems to change either with an object's motion or under the influence of a gravitational field. Then Davies introduces the reader to Stephen Hawking's search for a recon-

(continued on page 90)

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Michael Neufeld, (Free Press, 1994), ISBN 0-02-922895-6, 368 pages, clothbound, $21.95.

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From its bourgeois origins between the wars, to its plunder by the victorious Allies, German rocket technology evolved into the Space Age known today. After Neufeld's tour, readers will conclude that the V-2 was both a passport into the cosmos and a Faustian bargain with the Devil.

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GLASS (Full Aperture) Type 1

Made from high quality hand select glass, machine polished and **TRIPLE COATED** with a Nickel-Chromium alloy. Mounted in a machined aluminum cell ready to attach to telescope. Solar image is yellow-orange. No secondary filtering is necessary.

Aperture	Mounted	Aperture	Unmounted
2.4"	$49.00	2.4"	$39.00
3.1"	52.00	3.1"	42.00
3.5" to 4"	59.00	3.5 to 4"	49.00
4-1/4" to 5"	74.00	4-1/4" to 5"	64.00
6"	79.00	6"	69.00
8"	95.00	8"	85.00
10"	109.00	10"	99.00
11"	119.00	11"	109.00
12.5" to 13.1"	149.00	12.5" to 13.1"	129.00
14"	169.00	14"	149.00

40mm to 80mm Binoculars - Mounted .... $92.00 pr.

GLASS (Full Aperture) Type 2

Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

Aperture	Mounted	Aperture	Unmounted
2.4"	$62.00	2.4"	$52.00
3.1"	65.00	3.1"	55.00
3.5" to 4"	76.00	3.5 to 4"	66.00
4-1/4" to 5"	96.00	4-1/4" to 5"	86.00
6"	105.00	6"	95.00
8"	125.00	8"	109.00
10"	139.00	10"	129.00
11"	149.00	11"	139.00
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14"	199.00	14"	179.00

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GLASS (Full Aperture) Type 3

Coated to a neutral density of 4 for serious astrophotographers who desire the shortest possible shutter speeds with slow films. Solar image and optical quality same as type 1 & type 2. Type 3 filters are for photographic use only.

Aperture	Mounted	Aperture	Unmounted
2.4"	$79.00	2.4"	$65.00
3.1"	82.00	3.1"	69.00
3.5" to 4"	99.00	3.5 to 4"	79.00
4-1/4" to 5"	125.00	4-1/4" to 5"	110.00
6"	135.00	6"	115.00
8"	159.00	8"	139.00
10"	172.00	10"	152.00
11"	199.00	11"	179.00
12.5" to 13.1"	229.00	12.5" to 13.1"	209.00
14"	259.00	14"	239.00

Types 1 & 2 are for unlimited visual use and general photographic use. Instructions included with all filters, including tips on solar photography.

1/4 WAVE PREMIUM FILTERS

(Type 2 coating)

Aperture	Mounted	Aperture	Unmounted
2.4"	$129.00	2.4"	$119.00
3.1"	199.00	3.1"	189.00
3.5" to 4"	269.00	3.5 to 4"	259.00
5"	349.00	5"	339.00
6"	399.00	6"	389.00

Add $15.00 for Type 3 coating.

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MEETINGS & EVENTS

June 7-August 30
Naperville Astronomical Association Summer Observing Sessions, Naperville, Illinois. Club members will operate the 10" telescope at 7:30 p.m. Call if sky conditions are questionable. Contact George Simon, (708) 983-5029 or John Lehuta, (708) 257-0508 after 5 p.m.

June 17-24
5th Annual Grand Canyon Star Party, Yavapai Point, Grand Canyon National Park, Arizona. Sponsored by the Tucson Amateur Astronomy Association. Contact Dean Ketelsen, 1122 East Greenlee Place, Tucson, AZ 85719, (602) 293-2855, ketelsen@as.arizona.edu.

June 23-24
49th Annual Convention of the North Central Region of the Astronomical League, Moorhead State University, Moorhead, Minnesota. Sponsored by the Fargo-Moorhead Astronomy Club. Contact Registrar, Fargo-Moorhead Astronomy Club, Moorhead State University, Moorhead, MN 56563.

June 23-26
Astro Atlantic '95, New Brunswick, Canada. Sponsored by the New Brunswick Astronomers and the Hampton Astronomy Club. Contact Doug St. Onge, 4 Campbell Street, Gondola Point, New Brunswick, E2E 1N7 Canada, (506) 847-1923.

June 24-25
Universe '95, College Park, Maryland. Contact Universe 95, Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112, (415) 337-1100 or fax (415) 337-5205.

June 27-July 3
Mid-Atlantic Star Party, Camp Reeves, near Carthage, North Carolina. Sponsored by the Occoneechee Council BSA. Contact MASP, Occoneechee Council BSA, P.O. Box 41229, Raleigh, NC 27629, (919) 362-5194, starman@email.unc.edu.

June 29-July 2
General Assembly, Windsor, Ontario. Sponsored by The Royal Astronomical Society of Canada. Lecture, "Comet Impact - Lessons Learned" will be given by Carolyn Shoemaker. Contact Frank J. Shepley, 344 South Middle Rd. R.R. #2, Maidstone, Ontario NOR 1KO, Canada, (519) 723-2389 or e-mail, sheple6@server.uwindsor.ca.

July 2-4
WOW '95, Hartman Creek State Park, Waupaca, Wisconsin. Sponsored by the Northeast Wisconsin Stargazers. Contact Don Wyman, 1065 Laager Lane, Oshkosh, WI 54901, (414) 233-3083.

July 8
Night of Discovery, British Columbia, Canada. Sponsored by The Pacific Observatory of Blackcomb. Contact John Nemy, The Pacific Observatory, P.O. Box 1218, Whistler, British Columbia V0N 1B0 Canada, (604) 932-3467.

July 9-14
San Diego '95 Symposium, San Diego, California. Sponsored by the International Society for Optical Engineering. Contact SPIE, P.O. Box 10, Bellingham, WA 98227-0010, (360) 676-3290, at spie@spie.org.

July 20-22
ALCON '95, San Antonio, Texas. Sponsored by the San Antonio Astronomical Association. Contact Valerie Kinnamon, ALCON-95 Registrar, P.O. Box 701261, San Antonio, TX 78270-1261.

July 21-23
Gateway to the Universe '95, Munro Park, Powassan, Ontario, Canada. Contact (705) 474-7666 or (705) 840-2636.

July 21-23
Northern Prairie Star Fest, Sarles, North Dakota. Sponsored by Deneb Observatory. Contact John Leppert, Deneb Observatory, RR 1, Box 25, Sarles, ND 58372-9618.

July 25-30
Nebraska Star Party, near Valentine, Nebraska. Sponsored by the Omaha Astronomical Society and the Prairie Astronomy Club. Contact Nebraska Star Party Coordinator, (402) 466-4170.

July 27-30
Huronia Star Party '95, Ontario, Canada. Sponsored by the South Simcoe Amateur Astronomers. Contact Henri Van Bemmel, 140 Erskine Avenue, #1502, Toronto, Ontario M4P 1Z2 Canada, (416) 481-9937.

July 28-30
4th Annual Star Party, Austin, Minnesota. Sponsored by the Cedar River Astronomy Club. Contact Keith Snyder, 407 15th Street S.E., Austin, MN 55912, (507) 433-1903.

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NovaEast '95, Fundy National Park, New Brunswick, Canada. Sponsored by the Halifax Centre of the RASC as well as various regional clubs. Contact Douglas Pitcairn, 13 Ferguson Road, Darmouth, Nova Scotia B3A 4J8 Canada, (902) 463-7196, pitcairn@tuns.ca.

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Rocky Mountain Star Stare '95, Pike National Forest, Colorado. Sponsored by the Colorado Springs Astronomical Society. Contact Mike Frazier, CSAS, P.O. Box 62022, Colorado Springs, CO 80962, (719) 591-9349.

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3rd Annual Millennial Foundation Conclave, Denver, Colorado. Sponsored by the First Millennial Foundation. Contact Theresa Hamilton, P.O. Box 347, Rifle, CO 81650, (303) 625-5052.

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Curious Color Cosmos, British Columbia, Canada. Sponsored by The Pacific Observatory of Blackcomb. Contact John Nemy, The Pacific Observatory, P.O. Box 1218, Whistler, British Columbia V0N 1B0 Canada, (604) 932-3467.

August 12

Perseid Meteor Shower, British Columbia, Canada. Sponsored by The Pacific Observatory of Blackcomb. Contact John Nemy, The Pacific Observatory, P.O. Box 1218, Whistler, British Columbia V0N 1B0 Canada, (604) 932-3467.

August 25-27

Annual Northwoods Starfest, Fall Creek, Wisconsin. Sponsored by the Chippewa Valley Astronomical Society. Contact Ray Forsgren, 4856 Inlet Drive, Chippewa Falls, WI 54729.

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Eastern Iowa Star Party, near Dixon, Iowa. Sponsored by the Quad Cities Astronomical Society. Contact William Myers, Quad Cities Astronomical Society, P.O. Box 3706, Davenport, IA 52808, (319) 359-4286. □

Clubs, please submit announcements four months before the event to ASTRONOMY, Meetings & Events, P.O. Box 1612, Waukesha, WI 53187-1612. Readers, please include a self-addressed envelope when you write groups for information.

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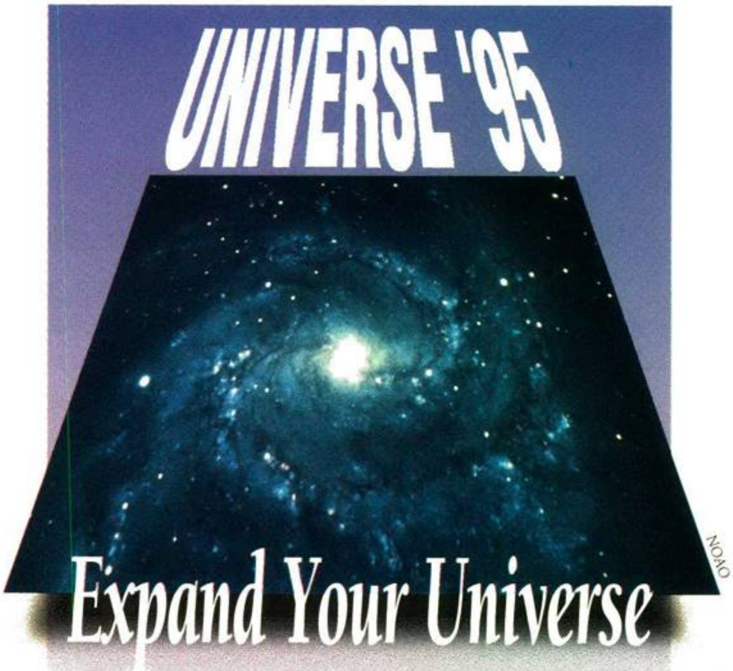

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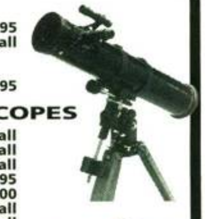

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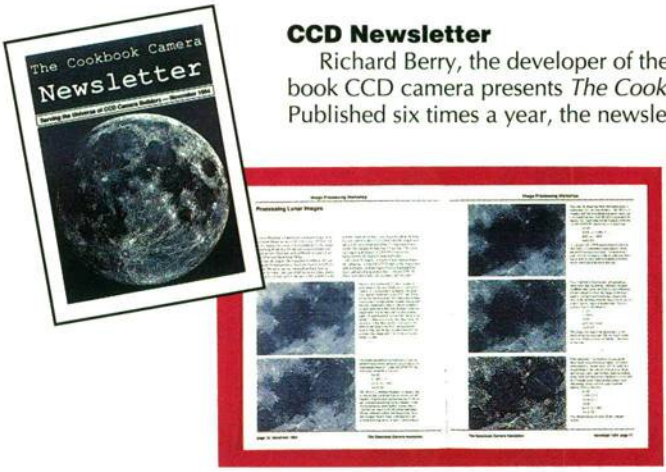

CCD Newsletter

Richard Berry, the developer of the build-it-yourself Cookbook CCD camera presents *The Cookbook Camera Newsletter.* Published six times a year, the newsletter provides cookbook camera construction pointers, picture-taking tips, and image-processing advice. Each issue also spotlights pictures taken by cookbook camera owners.

The Cookbook Camera Newsletter, 22614 N. Santiam Hwy, Lyons, OR 97358, (503) 859-3030. $28 for six issues.

Upgraded Newtonian Telescope

Celestron offers its redesigned 4½-inch f/7.9 reflector, the C4.5, with a larger (29.8mm minor axis) secondary mirror for better field-of-view illumination. The upgraded package also comes with a 6x30 finder and 26mm multicoated Plössl eyepiece. The C4.5 includes a German equatorial mount and a fixed-height wooden tripod with accessory tray.

Celestron International, 2835 Columbia Street, Torrance, CA 90503, (310) 328-9560, fax (310) 212-5835. Model #31028 - C4.5: $1,030.

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Globe Sales, P.O. Box 155, Champlain, VA 22438-0155, (804) 443-4813. $16.99 plus $3 shipping and handling; Virginia residents add $0.76 sales tax.

This department presents new product announcements issued by manufacturers. Product information is as supplied by the manufacturers or distributors. All prices are suggested retail. Suppliers should send announcements and color photographs of their products to the attention of John Shibley.

Treasures Of Deep Space

Deep-sky Object Poster

Treasures of Deep Space features color photos of nebulae, galaxies, and star clusters taken by professional and amateur astrophotographers. Descriptions under each photo provide object information and mention who took the image. The 24x36-inch poster is printed on glossy poster stock and comes rolled in a plastic storage tube.

MindMatter Publishing, 9685 Genesee Ave., Suite G-2, San Diego, CA 92121, (619) 558-9233, fax (619) 558-8490. $9.95 plus $3 shipping and handling.

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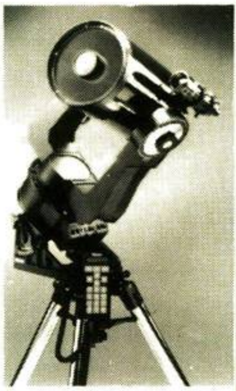

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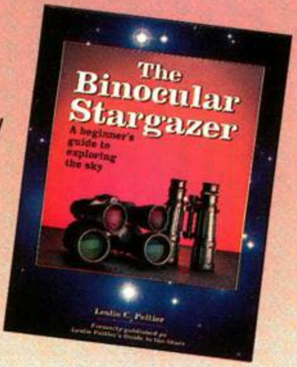
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Sky & Earth Binoculars

Nikon's newest binocular line touts an eye relief that is double that of most binoculars on the market. A longer eye relief, the distance between a binocular's eyepiece lens and its focal plane, benefits observers who wear eyeglasses. The 7x50 Wolverine has an eye relief of 16.4mm, while the Lemur 7x35 (bottom), Talon 8x40 (top), and Kestrel 10x50 have 18.3mm eye relief. Each of these models has an all-metal chassis housed in a polycarbonate shell and are rubber-coated for durability and an easy grip. The optics are fully multi-coated and use BaK 4 prisms. Each binocular center focuses; the right eyepiece has a separate, click-stop focus control to compensate for left/right eye vision differences. The Sky & Earth series comes with a 25-year limited warranty.

Nikon Sport Optics, 1300 Walt Whitman Road, Melville, NY 11747-3064. (516) 547-4200. Lemur 7x35: $216.40; Wolverine 7x50: $261; Talon 8x40: $238; Kestrel 10x50: $265.20.

Anti-astigmatism Eyepiece Lens

Near- or far-sighted telescope users can simply refocus a telescope after removing their eyeglasses. But this solution doesn't work for astigmatism sufferers. Custom Ophthalmics now markets a thin correction lens that presses into the rubber eyecups found on most eyepieces. The lenses are coated on both sides for maximum image contrast and they fit binoculars (the Starpoint BN lens) as well as 1¼- and 2-inch eyepieces (Starpoint 125, 200). All come with a 30-day money-back guarantee. Include an up-to-date prescription from an ophthalmologist when ordering.

Custom Ophthalmics, 11603 Hampstead Dr., Fredericksburg, VA, 22407. Voice or fax, (703) 786-9276. Prescription ranges: PL to –2.25: $59.95; –2.50 to –3.50: $69.95; –3.75 to –4.75: $79.95. Call for prescriptions greater than –5. Binocular owners save 15% when ordering two of the same prescription. Uncoated lenses are $10 less.

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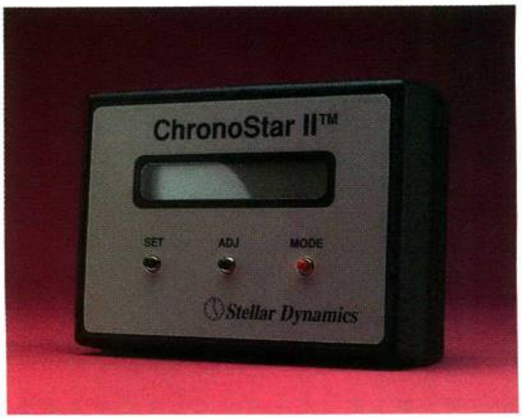

With the push of a button, Chronostar II provides precise Universal Time, Greenwich sidereal time, local mean time, or local sidereal time. A quartz-driven microprocessor gives the clock an accuracy of 0.12 seconds. The LCD display is not backlit so it won't ruin night vision and shuts off when not in use. The pocket-sized clock weighs seven ounces and a 9-volt battery powers it for up to six months. Stellar Dynamics also markets *SkyClock*, a PC-compatible program that sets your computer's internal clock by dialing up an atomic clock in Colorado.

Stellar Dynamics Company, P.O. Box 765, Horsham, PA 19044-7065. Voice or fax, (215) 465-6462. Chronostar II: $87.95; SkyClock: $19.99; purchased together: $97.95. COD orders accepted; PA residents add 6% sales tax.

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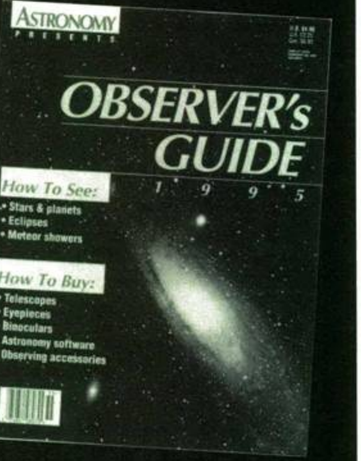

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RESOURCES & PHOTOFACTS

David Malin's Universe (page 30)

David Malin: A View of the Universe by David Malin (Cambridge University Press, 1993). A lavishly illustrated, large format book that presents a beautiful collection of some of the best color photographs of nebulae, star clusters, galaxies, and galaxy clusters.

South African Comet Crash Diary (page 46)

"Jupiter's Embattled Cloudtops," by David J. Eicher, ASTRONOMY, December 1994. A round-up of amateur observations of Comet Shoemaker-Levy 9's crash with Jupiter.

For information on the Astronomical Society of Southern Africa, write ASSA c/o SAAO, P.O. Box 9, Observatory, 7935, South Africa; phone: 27-22-761-2112; e-mail: mnassa@saao.ac.za

Internet users can access the World Wide Web to acquire impact images. One collection is at http://newproducts.jpl.nasa.gov/sl9/sl9.html.

October's Eclipse (page 64)

Chasing the Shadow by Joel K. Harris and Richard L. Talcott (Kalmbach, 1994). A complete guide to viewing solar eclipses, including how to plan a trip to see one.

Total Solar Eclipse of 1995 October 24 by Fred Espenak and Jay Anderson (NASA Reference Publication 1344, 1994). Contains detailed predictions, weather prospects, tables, and maps for the October eclipse.

Are the Best Lunar Photographers French? (page 68)

The Moon: An Observing Guide for Backyard Telescopes, by Michael T. Kitt (Kalmbach Books, 1992.) A thorough guide to the main lunar features visible in a small telescope. Photographic contributors include, among others, Christian Arsidi, Jean Dragesco, and Gérard Therin.

Atlas of the Moon, by Antonín Rükl, edited by T.W. Rackham (Aventinum and Kalmbach, 1990). Contains detailed maps of the main lunar features. Although it has more maps than photographs, it's an excellent resource for lunar photographers. ☐

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pp. 30-31: David Malin, Royal Observatory, Edinburgh; inset: David Malin, Anglo-Australian Telescope Board; **pp. 32-36:** David Malin, Royal Observatory, Edinburgh, and Anglo-Australian Telescope Board; **p. 37:** David Malin, Anglo-Australian Telescope Board; **p. 47:** P. Pienaar, Large Magellanic Cloud; 50mm lens at f/2.8, 20 minutes, Kodacolor 400 print film; **p. 65:** Rajiv Gupta, 5-inch f/10 refractor, Ektar 25 film, 1/125-second exposure on July 11, 1991; **p. 66, left:** Brenda Culbertson, July 11, 1991; **p. 66, right:** Andreas Gada, 1/100-second exposure on July 11, 1991; **p. 68:** Gérard Therin, 9-inch SCT at f/65, Tech Pan film, 1½-second exposure; **p. 70:** Christian Arsidi, 12-inch Cassegrain at f/48, Tech Pan film, 1½-second exposure; **p. 71, top:** Stéphane Dumont, 9-inch f/12 SCT, SBIG ST-6 CCD camera, composite of ten 30-second exposures; **bottom left:** Christian Arsidi, 12-inch Cassegrain at f/60, Tech Pan film, 1-second exposure; **bottom right:** Gérard Therin, 9-inch SCT at f/65, Tech Pan film, 1¾-second exposure; **p. 72, top:** Jean Dragesco, 14-inch Cassegrain at f/45, 400 ISO film, 1-second exposure; **bottom:** Christian Arsidi, 12-inch Cassegrain at f/48, Tech Pan film, 1½-second exposure; **p. 73, top left:** Gérard Therin, 9-inch SCT at f/65, Tech Pan film, 1¼-second exposure; **top right:** J. Paul Roux, 4.8-inch apochromatic refractor at f/17, Agfa Pan 25 film, 1-second exposure; **bottom:** Stéphane Dumont, 9-inch f/12 SCT, SBIG ST-6 CCD camera, composite of ten 30-second exposures; **p. 74:** Greg Terrance; **p. 78, top:** Jeff Corder; **middle top:** Michael Sweetman; **middle bottom:** David J. Eicher; **bottom:** Rex Evans; **p. 105, top:** Don Trombino and Jeff Pettitt, 6-inch refractor at f/29, Tech Pan film, 1/60-second exposure using a mylar filter on February 10, 1995. False color was added in the darkroom; **middle:** Don Trombino and Jeff Pettitt, 6-inch refractor at f/29, Tech Pan film, 1/250-second exposure using a DayStar calcium-K filter on February 10, 1995. False color was added in the darkroom; **bottom:** Don Trombino and Jeff Pettitt, 6-inch refractor at f/29, Tech Pan film, 1/250-second exposure using a DayStar H-alpha filter on February 10, 1995. False color was added in the darkroom; **p. 106, top:** Darren Drake, 17.5-inch f/4 reflector, GBC 505E video camera; **middle:** John Sefick, 25-inch f/4.5 reflector, ST-6 CCD camera; **bottom:** Don Parker, 16-inch f/5 reflector, SpectraSource Lynxx PC CCD camera; **p. 107:** Robert B. Slobins/Phototake, 105mm lens at f/2, Fuji NPS 160 film, 3-second exposure taken on January 27, 1995, from Weehawken, New Jersey; **p. 108:** Carl Weber, 10-inch f/6 SCT, Konica 3200 film, 10-minute exposure.

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The Stratford-upon-Avon Astronomical Society is a recently formed organization in the United Kingdom. We welcome visitors on a regular basis, exchanging various cultural activities. Eventually, we hope to meet our colleagues overseas. If you have an interest, drop us a line. Contact John Harrison, Secretary, Stratford-upon-Avon Astronomical Society, 14 Avon Crescent, Stratford-upon-Avon, Warwickshire, CV37 7EU, United Kingdom.

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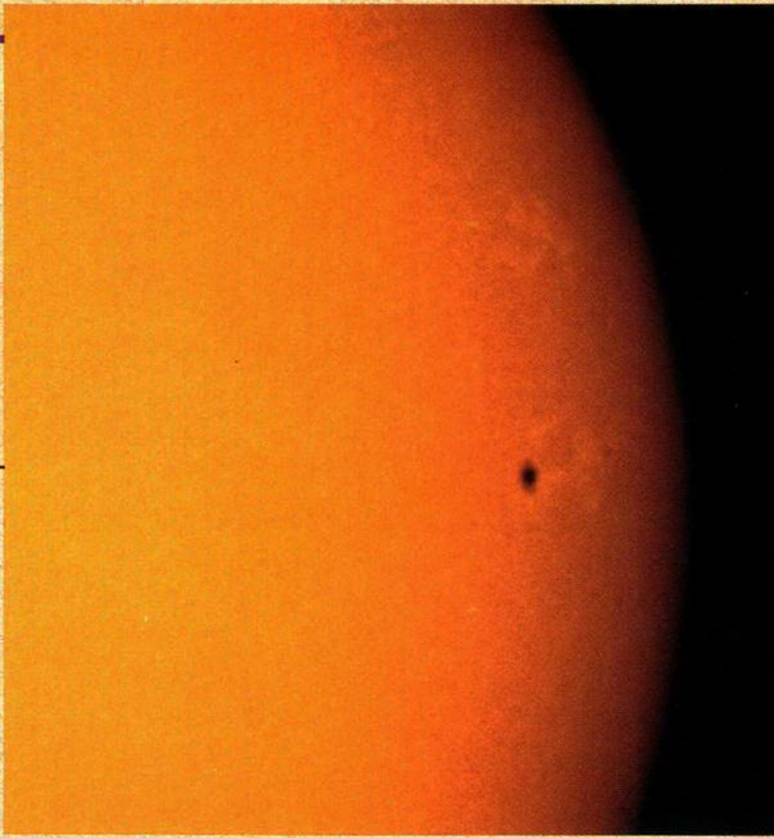
READER REPORTS

A Slice of Sun

"I've been experimenting with solar photography for many years now," says Don Trombino of Deltona, Florida. Trombino operates the Davis Memorial Observatory in his backyard and has spent hundreds of hours photographing and observing the Sun with a variety of filters. Assisted by his friend Jeff Pettitt, Trombino has been conducting experiments with filters, exposures, and developers to determine the optimum combinations for recording the Sun in three wavelengths.

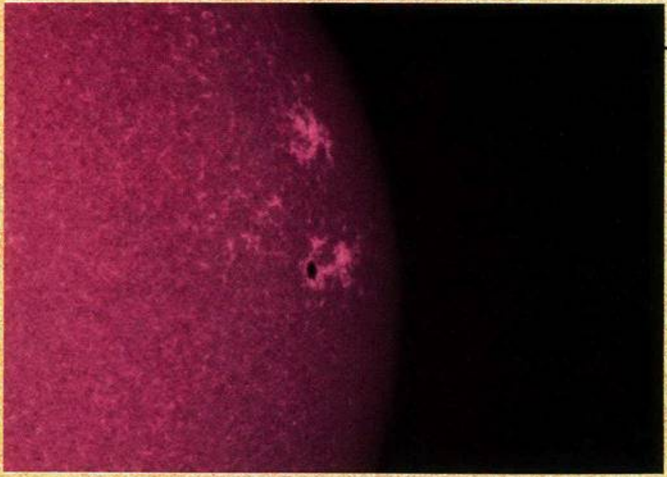
Trombino and Pettitt use a 6-inch refractor typically at f/29 and Tech Pan film to image details on the Sun's surface. A white-light photo of the Sun on February 10, 1995, shows little more than a sunspot near the solar limb, faculae surrounding the spot, and limb darkening. This exposure was made with a mylar Solar Skreen filter. The same region imaged with a calcium-K interference filter (at 3933.7 Å), however, reveals detail in the Sun's lower chromosphere. The faint faculae visible in the white-light image now stand out against the solar disk. A third view of the same slice of the Sun in hydrogen-alpha light reveals the differences various wavelengths of light can bring out in solar features. In all three cases, Trombino and Pettitt added colors to the images in the darkroom to approximate their actual appearance.

Freeway Meteor Observing. On Sunday evening, January 22, 1995, Kevin Jones was heading home on



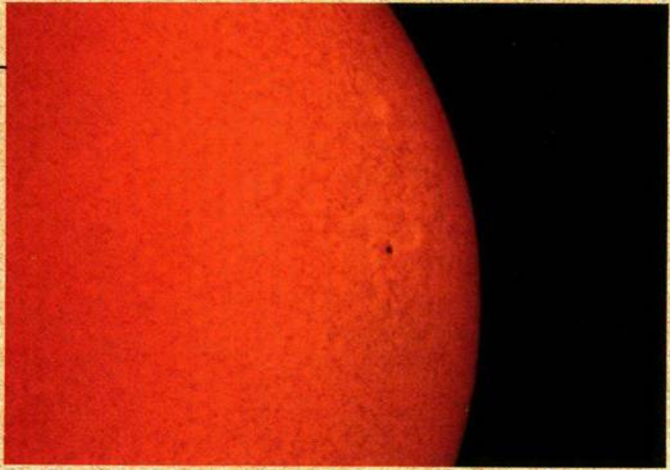
The Sun in White Light

by Don Trombino and Jeff Pettitt (6-inch refractor at f/29, Tech Pan film, 1/60-second exposure using a mylar filter taken February 10, 1995. Color added in the darkroom)



The Sun in Calcium Light

by Don Trombino and Jeff Pettitt (6-inch refractor at f/29, Tech Pan film, 1/250-second exposure using a DayStar calcium-K filter taken February 10, 1995. Color added in the darkroom)



The Sun in Hydrogen-Alpha Light

by Don Trombino and Jeff Pettitt (6-inch refractor at f/29, Tech Pan film, 1/250-second exposure using a DayStar H-alpha filter taken February 10, 1995. Color added in the darkroom)

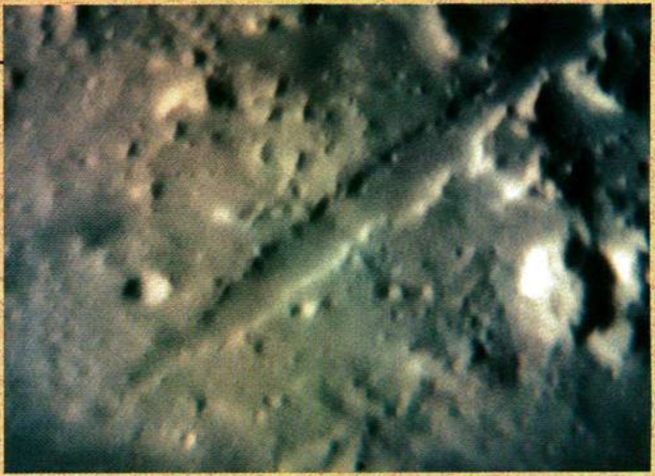
Virginia's Interstate 64. A student at the College of William and Mary in Williamsburg, Jones is an experienced meteor observer. "About 15 miles west of Williamsburg, at 5:30 p.m. EST, I saw the tail end of a bright green bolide as it flashed overhead." The meteor was "brighter than Venus" and was dropping toward the south-southeast horizon when it fragmented into numerous pieces. "It was quite obvious against a rather bright twilight sky," says Jones.

Blue Flash Times Two. "As a man on the downhill side of my sixth decade, I am not especially enamored with sunsets," says Robert F. Wilson, of Kingman, Arizona. But he does enjoy taking in sunrises. In September 1994 he was walking through the countryside near his house to watch the Sun ascend from behind the Peacock Hills.

"As I was walking south," reports Wilson, "I kept eyeing the concentration of light at the place where the Sun would rise." He followed the glow as it lay behind the north foot of a sharp peak. He saw a brilliant blue flash. "And I mean blue," he says.

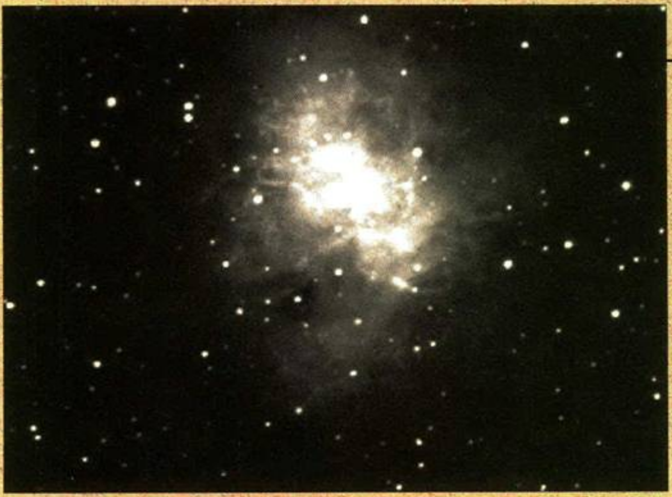
"As I continued walking, the edge of the Sun seemed to climb the slope of the hill, prolonging the blue color for a full two seconds." A few seconds later the flash emerged again on the south side of the peak with another blue flash. Because of the geography of the mountain and Wilson's movement, it was a blue flash times two. Have others spotted blue or green flashes to share with the readers? □

ASTRONOMY wants to hear about your observations of the sky. Send reports, sketches, and photographs to David J. Eicher, Reader Reports Editor, ASTRONOMY, P.O. Box 1612, Waukesha, WI 53187. Please label each photo with name, address, and social security number. You may send written reports via the Internet to: rreports@astronomy.com



The Moon's Alpine Valley

by Darren Drake (17.5-inch f/4 reflector, GBC 505E video camera)



The Crab Nebula in Taurus

by John Sefick (25-inch f/4.5 reflector, ST-6 CCD camera)

Jupiter's Moon Ganymede

by Don Parker (16-inch f/5 reflector, SpectraSource Lynxx PC CCD camera)

The Moon Passes Venus

by Robert B. Slobins/Phototake (105mm lens at f/2, Fuji NPS 160 film, 3-second exposure taken on January 27, 1995, from Weehawken, New Jersey)

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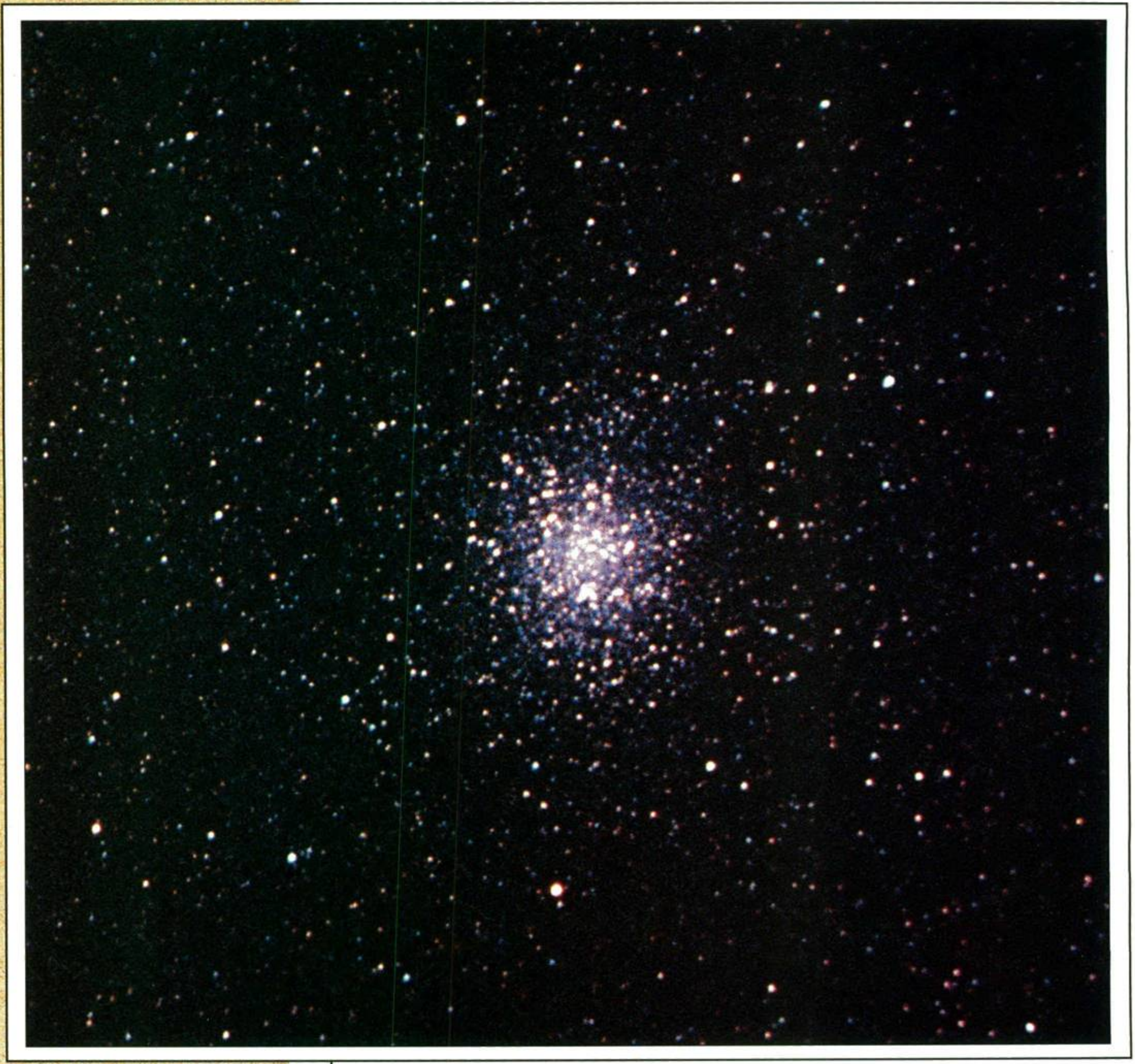

Globular Star Cluster M22 in Sagittarius

by Carl Weber
(10-inch f/6 SCT, Konica 3200 film, 10-minute exposure)

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I'm a "fun astronomer" and a wide-field freak. First light with the 35 was the late rising Lagoon nebula. I really embarrassed myself with exclamations I haven't used since adolescence like, 'holy cow!,' 'gee whiz!' and several others, not repeated here. What a view! Flatness of field to the edge; clarity and detail of nebulosity never dreamed of in my scope; separation and detail of the 'hot-star' area; and definition of the lagoon area itself.

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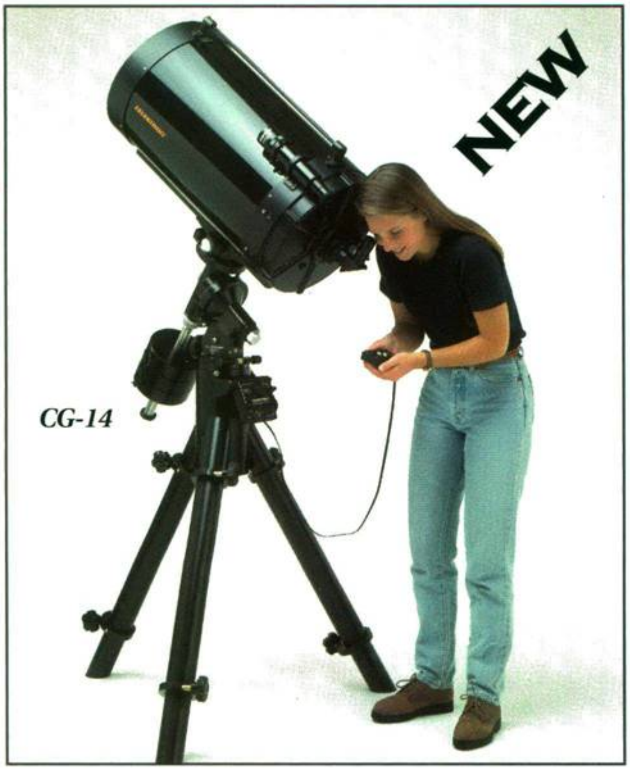

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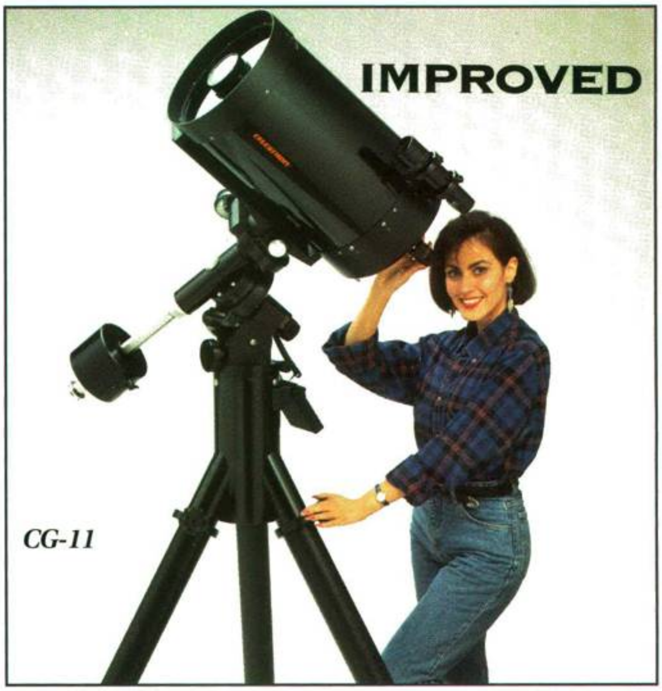

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